The Engineer

LONDON, FRIDAY, NOVEMBER 14, 1941

PUBLIC NOTICES

NORTH WELLAND INTERNAL DRAINAGE BOARD

TENDERS INVITED FOR THE SUPPLY AND ERECTION OF PUMPING PLANT

The Above Board Invites TENDERS for the SUPPLY and ERECTION of PUMPING PLANT for the drainage of approximately 600 acres of land in the Fen Area. Inspection of the site may be made, and full particulars obtained from the undersigned on appointment in writing. Tenders, in a plain sealed envelope, bearing no name or mark indicating the identity of the sender, endorsed "Pumping Plant," must be received by the Clerks of the North Welland Internal Drainage Board, 11, Market Place, Spalding, not later than Monday, 28th November.

The Board does not bind itself to accept the lowest or any Tender and the acceptance of any Tender is subject to the approval of the Ministry of Agriculture and Fisheries.

N. W. HAMPSON, Assoc. M. Inst. C.E.,
Engineer to the Board.

22, Station Street,
Spalding. 7923

GOVERNMENT OF NORTHERN IRELAND

VACANCIES FOR ASSISTANT CIVIL ENGINEERS

The Ministry of Finance invites APPLICATIONS for APPOINTMENTS as ASSISTANT CIVIL ENGINEERS for the Preparation of Drainage Schemes for the alleviation of Flooding on a number of rivers. The employment will be temporary, and will be terminable at any time on one month's notice. A number of the men appointed will, if satisfactory, be offered further employment on the supervision of the execution of the work.

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REMUNERATION.—The rates of salary will be settled having regard to the qualifications and experience of selected candidates, but the maximum proposed is £600 per annum.

CLOSING DATE.—Applications must be received on or before the 1st December, 1941. Forms of application on which full details of experience and salary expected should be stated are obtainable from ROOM 327, ADMINISTRATIVE BUILDINGS, STORMONT, BELFAST. 7920

LEICESTERSHIRE EDUCATION COMMITTEE

MELTON MOWBRAY & DISTRICT COUNTY TECHNICAL COLLEGE

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W. A. BROCKINGTON,
Director of Education.

County Education Offices,
Grey Friars, Leicester. 7913

SITUATIONS OPEN

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TO ADVERTISERS UNDER BOX NUMBERS IN SITUATIONS OPEN SECTION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge, and co-operation is asked for.

IMPORTANT

Advertisers in Situations Open Column should make themselves acquainted with the terms of

STATUTORY RULES & ORDERS 1940 No. 877

RESTRICTION ON ENGAGEMENT ORDER

WANTED, CHIEF PLANT ENGINEER for Heavy Engineering Works, Birmingham District. Must have knowledge of constructive work and routine maintenance control. State age, experience and salary required.—Address, 7924, The Engineer Office. 7924 A

The Engineer

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SITUATIONS OPEN

WANTED, WORKS MANAGER for Structural Steelwork, Welded Platework, and General Engineering Works in Midlands, having turnover of £100,000 p.a. We require a man capable of Controlling all Labour, Output and Costs, Reorganising and Maintaining the works efficiently. The firm is scheduled Essential Works Order, and is very progressive. When writing, state age, experience, salary; send copy testimonials.—Address, P3639, The Engineer Office. P3639 A

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MACHINE SHOP SUPERINTENDENT, Fully experienced and used to the Controlling of Labour, REQUIRED for large Engineering Works in the Midlands. Also MACHINE SHOP SUPERVISOR for Night Shift.—Write, stating age, full details of experience and salary required to 7918, The Engineer Office. 7918 A

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SITUATIONS WANTED

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CLASSIFIED ADVERTISEMENTS CLOSE FOR

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The Engineer

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The Charges for Classified Advertisements are 1/- per line up to one inch—minimum charge, 4/-: those occupying one inch or more at the rate of 12/- per inch. Orders must be accompanied by a remittance. The rates for Displayed Advertisements will be forwarded on application. Classified Advertisements cannot be inserted unless delivered before TWO o'clock on Wednesday afternoon.

Letters relating to the Advertisement and the Publishing Departments of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

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If the Man You Are Seeking is Not Amongst those Advertising in this Column, a Small Announcement in the "Situations Open" Column will Quickly and Economically Produce the Right Selection of Applicants, at the same time Eliminating Waste of Effort, Waste of Time, and Waste of Opportunity. The charge is Four Lines or under, 4s.; each Additional Line, 1s.; Box Numbers, 6d. extra, which includes despatch of all replies.

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For continuation of Small Adverts ments see page 64

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A Seven-Day Journal

Britain's Growing Power

In his address on the occasion of the Lord Mayor's luncheon at the Mansion House on Monday last, November 10th, the Prime Minister, Mr. Winston Churchill, made reference to the growing power of Great Britain. A year ago, he said, we were the sole champion of freedom in arms. We were ill-armed and far outnumbered even in the air. Now a large part of the United States Navy was constantly in action against the common enemy. The valiant resistance of the Russian nation had inflicted most frightful injuries upon German military power, and at the present moment the German invading armies, after all their losses, lay on the barren steppes, exposed to the approaching severities of the Russian winter. Now we had an Air Force which, Mr. Churchill said, was at least equal in size and numbers, not to speak of quality, to the German air power. A battle fleet had been sent back into the Mediterranean sea for the destruction of German and Italian convoys. The passage of our supplies in so many directions through that sea, and the broken morale of the Italian Navy, showed that we were still masters there. Owing to the effective help which we were getting from the United States in the Atlantic, the sinking of the "Bismarck," the completion of our splendid new battleships and aircraft carriers of the largest size, as well as the cowing of the Italian Navy, we now felt ourselves strong enough to provide a powerful naval force of heavy ships with its necessary ancillary vessels for service, if needed, in the Indian and Pacific Oceans. We stretched out the long arm of brotherhood and motherhood to the Australian and New Zealand people and to the Indian people whose Army had been fighting with so much distinction in the Mediterranean theatre. Should the United States become involved in war with Japan, the British declaration would follow within the hour. It would, Mr. Churchill said, seem a very hazardous venture for the Japanese people to plunge quite needlessly into a world struggle in which they might well find themselves opposed in the Pacific by states whose populations comprised nearly three-quarters of the human race. If steel was a nation's foundation for modern war, it would be rather dangerous for a Power like Japan, whose steel production was only about 7,000,000 tons a year, to provoke quite gratuitously a struggle with the United States, whose steel production was now about 90,000,000 tons a year. That statement took no account of the powerful contribution which the British Empire could make in many ways.

Britain's October Air Offensive

Continuing their offensive operations against the enemy, Fighter Command aircraft destroyed more of the enemy's fighters during October than were lost by the R.A.F. During the month fighter losses in the West amounted to fifty-two, against seventy-six German fighters destroyed. That success was scored despite operating mainly over enemy occupied territory in the face of heavy ground defences, as well as against a formidable part of the enemy's fighter force. British fighters helped to maintain Britain's air offensive both by escorting bombers on daylight raids and in offensive patrols as well as by direct attack on enemy land and sea objectives. On only two days, October 17th and 23rd, were no fighter operations reported, but on both days R.A.F. bombers were out against German targets. The weather in October prevented serious bombing in the West on one night in three, yet Britain's air offensive was actually slightly heavier than during the more favourable summer months. It was double that of October a year ago. The weather this October was, from a flying point of view, well below the average. Despite that, Bomber Command aircraft carried out seventeen attacks on targets in Germany alone during October, besides many more on German targets in occupied France and the Low Countries. In these attacks eighty British bombers were lost, but enormous damage was done. Altogether the tonnage of bombs dropped by Bomber Command alone, added to that for the previous two months, amounted to 10,000 tons. During the month German bomber aircraft raided Britain on a very much lighter scale on sixteen occasions. They lost twenty-three aircraft in these raids, a substantially higher proportion of the numbers engaged compared with Britain's losses. Altogether the R.A.F. destroyed 100 German aircraft—fighters, bombers and others—besides others on the ground. Fighter, Bomber and Coastal Command together made over 300 separate attacks on enemy shipping in the North Sea area, an average of ten separate attacks each day during which seventy-one enemy ships were sunk or damaged. In the Middle East British air attacks on Axis shipping were strikingly successful during the month, many enemy ships being attacked and thirty destroyed or damaged. Altogether 119 separate bombing raids on forty-four Axis targets were made during October by Middle East Command. In this theatre of war the R.A.F. lost forty-one aircraft altogether, against twenty-one enemy machines destroyed during the same period.

Wagons and Engines for Russia

On Monday last, November 10th, during an inspection of one of the Southern Railway company's works by Colonel J. J. Llewellin, Parliamentary Secretary to the Ministry of Transport, the thousandth goods wagon built by the Southern Railway Company to carry supplies to Russia was sent on its way. The wagon was part of a train which started on its long journey to the Persian Gulf, where, said Colonel Llewellin, the wagons were being sent to reinforce the railway facilities for getting supplies to Russia by that route. In peacetime, it was stated, the construction of a thousand goods wagons would have probably been scheduled as twelve months' work. Working night and day, men and women have completed the construction of 1000 goods wagons in ten weeks, with the co-operation of other railway companies who have helped with the supply of materials. It may also be stated in connection with the railway aid now being given to Russia that fifty London Midland and Scottish and ninety-two London and North-Eastern powerful goods locomotives have been equipped for overseas service, and made ready for aid to Russia. These engines, together with spare parts and tenders, have either been despatched or are now being despatched, some of them already being in service.

Building and Civil Engineering Labour

Under the Defence Regulations, Lord Reith, the Minister of Works and Buildings, has made an Order (S.R. & O., 1941, No. 1642) calling for a compulsory return from all persons who employ labour which is engaged in building or civil engineering activities. This Order does not apply, however, to those in respect of whom there is in force a certificate or provisional certificate issued by the Minister that he is registered under Regulation 56AB of the Defence (General) Regulations, 1939. The main purpose of the return, the Ministry states, is to obtain information as to the building and civil engineering labour which is employed in industries other than those of the civil engineering, contracting and building trades. The returns will therefore cover workpeople engaged on maintenance work as well as those who are employed by persons other than registered builders and civil engineering contractors. All such employers, in whatever industry they may be, are required to furnish returns of any workpeople who may be employed by them on building and civil engineering work. Information is required as to the number and trades of persons engaged in such activities and as to the value of work done by them in October, 1941. The trades involved include joiners and carpenters (when engaged on work in connection with building and civil engineering, but not on shop work), bricklayers, slaters and tilers, painters, plasterers, plumbers, glaziers and builders' labourers; also persons who are generally engaged in the construction, reconstruction, alteration, repair, maintenance, decoration or demolition of buildings or fixed works of construction. Such work is held to include excavation, levelling, the making of earthworks and foundations, the laying of pipes and sewers, the construction of roads, railways and the laying of railway tracks.

The Late Mr. Frank Pick

The science of modern transport has lost one of its leading exponents by the death, on Friday evening last, November 7th, at his London home, of Mr. Frank Pick, who was for many years attached to the London Passenger Transport Board, and on his retirement from the office of Vice-Chairman in 1940 fulfilled many Government inquiries and filled several Government offices. Mr. Pick, who would have been sixty-three years of age on November 23rd, was born at Spalding, Lincolnshire, and was educated at St. Peter's School, York. In 1902 he qualified as a solicitor, and a year later entered the service of the North-Eastern Railway Company under Sir George Gibb. When in 1906 Sir George Gibb removed to London to take over the management of the Metropolitan District and London Electric Railways, Pick accompanied him, and upon his retirement in 1907 was transferred to the staff of Mr. A. H. Stanley, now Lord Ashfield. In 1909 he became Traffic Development Officer. He was appointed joint assistant managing director of the companies comprising the Underground group in 1921 and became managing director in 1928. In 1933 he was appointed Vice-Chairman of the London Passenger Transport Board, and retired in 1940. He was appointed by the Minister of Transport to investigate the possibilities of the more effective use in wartime of British canals, and he completed that task in May last. His other work for the Ministry was to visit British ports and to advise the Minister on the speeding up of the discharge of cargoes. For a period of four months at the end of last year he was Director-General of the Ministry of Information.

Employment Returns

It was announced on Tuesday evening, November 11th, by the Ministry of Labour and National Service that the number of men and boys registered at Employment Exchanges in Great Britain as wholly unemployed at October 13th was 97,034, a decrease of 3014 as compared with September 15th. Of this total, 28,722 had been classified by interviewing panels as unsuitable for ordinary industrial employment. Those registered as on short time or otherwise temporarily suspended from work on the understanding that they were shortly to return to their former employment numbered 6620; this was a decrease of 1304 as compared with September 15th. Those registered as unemployed casual workers (being persons who normally seek their livelihood by jobs of short duration) numbered 9420, a decrease of 91 as compared with September 15th. The corresponding figures for women and girls at October 13th were 88,816 wholly unemployed, 13,832 temporarily stopped and 477 unemployed casual workers. Of those wholly unemployed, 3482 had been classified by interviewing panels as unsuitable for normal full-time employment and 4082 had been classified as unable for good cause to transfer to another area. As compared with September 15th, the numbers wholly unemployed showed a decrease of 7730, those temporarily stopped a decrease of 2217, and unemployed casual workers a decrease of 66.

Air Force Targets in Germany

No. XXIV

(*Continued from page 254, October 17th*)

Karlsruhe

DURING the months of August and September aircraft of the Bomber Command made several heavy attacks on objectives in the city and port of Karlsruhe. The railway yards and the industrial part of the city around the Rhine port were specially attacked, with our largest high explosive and with incendiary bombs, and it is reported that considerable damage was caused. In the attack which took place on the night of Tuesday, August 5th, the bombers were helped by the gale which was then blowing, which had the effect of carrying the clouds before it, leaving a clear moonlit sky over the targets, which on that evening included not only Karlsruhe, but also Frankfort-on-Maine and Mannheim. There was considerable anti-aircraft fire, which showed the importance of the targets selected, and several of our bombers did not return. On Tuesday and Wednesday, September 16th and 17th, Karlsruhe was again bombed, and one of the Wellington bombers came down as low as a few thousand feet above the city. Again, the important industrial and military objectives were heavily bombed, with, it is reported, considerable accuracy, and fires were started which were clearly observed for a long way on the homeward journey.

THE RHINE HARBOUR

The City of Karlsruhe

In the accompanying plan we show in outline the position of the city and the Rhine port. Karlsruhe is the capital of the State of Baden, and it has a population of something over 150,000 persons. It is situated about 6 miles from the river Rhine, and, as will be seen from one of our engravings, it is backed by the low hills of the Black Forest district. It owes its name and origin (Charles' Rest) to Margrave Karl Wilhelm of Baden-Durlach, who lived from 1709 until 1738, and transferred his residence to the then small town of Karlsruhe about 1715. Even in 1871 the population had not reached the 37,000 figure.

As the plan shows, the old part of the city is laid out to resemble a fan, the streets radiating out from the palace as a centre, the tower of the palace being easily seen from every road crossing. At one time the city had a well-known locomotive works, the Maschinenbaugesellschaft Karlsruhe, but in recent years the Reichsbahn has only employed the Karlsruhe works as a locomotive and wagon-repairing centre, with a branch works at Durlach.

Karlsruhe is without doubt one of the most important railway centres in South Germany, for it is situated at a junction of many important lines. There are good connections with Mannheim and Frankfort, and also with the Rhine and Ruhr areas, while the line from Paris through Strassburg also runs through the city, with connections to the Danube countries which have assumed such importance in the Russian campaign. Traffic from Holland to the south is also dealt with at Karlsruhe. Equally important from a railway and transhipment point of view is the connection to Switzerland and Italy by the St. Gothard and the Lötschberg tunnel routes.

It is well known that Italy has in recent months sought to cover her winter coal requirements by placing orders with Germany for fuel supplies. These orders were, it is understood, executed in the Ruhr area, and it may be assumed that the whole of this coal traffic, amounting to many thousands of tons of coal each month, has to pass through Karlsruhe, either by rail direct or by transhipment from Rhine barges to railway wagons at the Rhine harbour at Karlsruhe, which, with its surrounding industrial area, formed one of the principal targets in the recent raids.

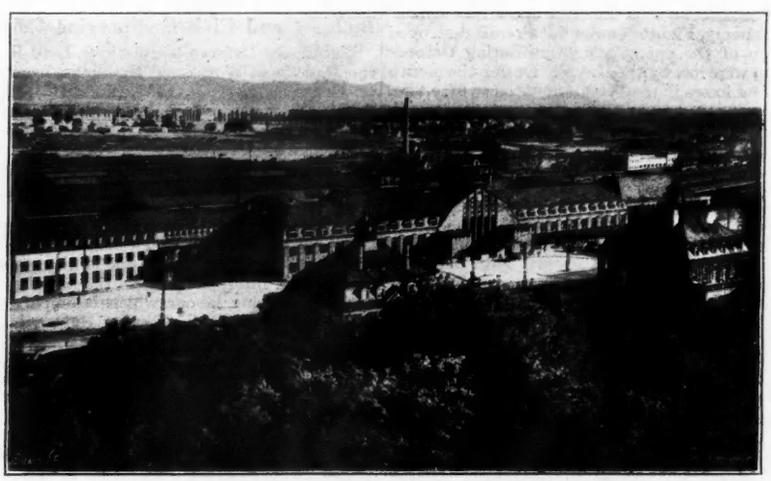
The Rhine Harbour

Some particulars of this inland port, which was constructed between the years 1898 to 1901 and was extended towards the end of 1916, may be of interest to our readers. Its importance has steadily increased since the last war, and it is now a busy centre for the transfer of goods from the Rhine steamers and barges to the railways in the south-western part of Germany for delivery in many cases to other parts of Europe.

The harbour to the west of the city is connected to the Rhine by a channel nearly 1 mile in length. Around the harbour there has grown up a large industrial area, well served by railway and canal connections, in which are to be numbered more than 100 different firms. Although for some years the competitive oil interests at Mannheim and Strassburg did not favour the setting up of a special oil harbour, tank facilities have since been added to the port, and are said to exceed in capacity 12,000,000 litres. Among the principal commodities handled at the harbour may be mentioned coal, coke, and oil fuels, building materials, corn and milled products, and washing materials. Chemicals used in the tanning industry are also dealt with, and there is a big trade in timber and in scrap iron.

As far back as 1930 the amount of goods which were transhipped from Rhine vessels to the Reichsbahn systems had risen to 2·2 million tons per annum, which compares with a figure of 1½ million tons before the last war. For this 1930 figure about ten freight trains per day were required, in addition to which there was an increasing amount of packages and goods which were sent away by express goods traffic.

The construction of the Rhine harbour was



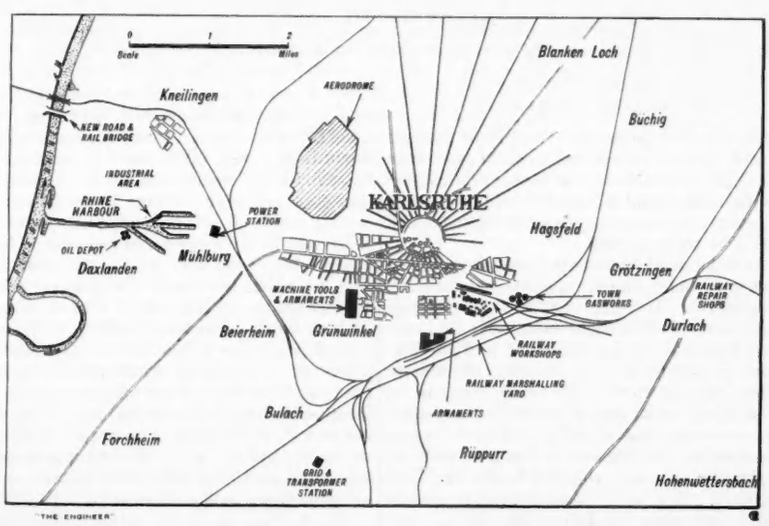
MAIN RAILWAY STATION

begun in 1898. As will be seen from the accompanying drawing, it is built on the west side of the city and is connected to the river Rhine by a long straight channel. This channel has a length of 1500 m., and its depth and that of the whole harbour system is maintained equal to that of the Rhine. At the entrance to the channel from the river an auxiliary harbour has been built, with a length of 350 m. and a width of 95 m., thereby permitting easier navigation for entering ships. The channel from the river to the harbour basins has a width of 65 m., and provision was made before the present war to increase its width to 77 m.

The first harbour basin to be built was the centre basin opposite to the entrance canal. It has a total length of 800 m., and a bottom width of 80 m. The North and South basins have each a length of about 740 m., and a bottom width of about 65 m. The water space between the ends of the three basins serves the purpose of a turning space, and is large enough to accommodate the largest Rhine vessels.

With the growth of trade and of the industrial area, plans were drawn up in 1913 for the construction of two further basins to the south of the entrance channel, Nos. IV and V. The first of these two harbour basins was begun early in the last war, but it was not completed and placed in service until the summer of 1916. The No. V basin alongside was planned, but it was not built until some years later.

Just after the last war, in 1920, the equipment of the port included eleven transporter bridges with cranes, designed for the rapid handling of coal and coke, sixteen cranes and a large floating crane, grain-handling plant of fixed and portable types, cranes with lifting magnets for handling iron and steel scrap, and coal-sorting plant, besides numerous capstans for the hauling and shunting of wagons. The industrial area included more than ten coal-handling and exporting concerns, ten timber firms and transport undertakings, seven iron and steel firms, and also works for the manufacture of building materials, saw mills, and linseed oil factories and storage tanks. Some 400 to 500 harbour officials were employed, with about 2000 workers.



PLAN OF KARLSRUHE AND NEIGHBOURHOOD

Railway Station and Marshalling Yards

Another engraving accompanying the present article shows the main passenger station at Karlsruhe, which was completed about 1913. The first Karlsruhe railway station was closer to the city, and was built in 1834 and enlarged some time later. By about 1843 some twenty trains a day were running through Karlsruhe. When the present station was opened in 1913, with its nearby goods yards and marshalling yards, and associated wagon and locomotive works at Karlsruhe and Durlach, the traffic passing through it had risen to over 280 passenger trains, sixteen express freight trains and over 160 ordinary goods trains each day. Although the marshalling yard is not mechanised, it is of modern construction, and the signalling by Siemens and Halske, of Berlin, is electric, and is one of the first of its kind to be erected in Baden. The station has a handsome entrance hall. It consists of eight platforms, most of which are covered. The main entrance hall has a length of 287 m., a width of 45 m., and heights of 8·7 m. and 15·7 m. to the roof.

From what has been said, it will be appreciated that any damage done during our raids to the marshalling yards, stations, locomotive repair shops, power supply, and general railway facilities must inevitably have dislocated the German and Italian coal traffic over the St. Gothard and Lötschberg tunnel lines, no matter whether the coal was brought by rail direct from the Ruhr or shipped by Rhine barges and loaded on to the railway at Karlsruhe.

The Education of Engineers*

By Professor C. E. INGLIS, M.A., LL.D., F.R.S.

No. II

(*Continued from page 320, November 7th*)

The Humanities in Relation to Engineering Education

I WILL now put in a plea for leavening an engineering education with some small measure of the humanities.

There is much truth in the saying that the proper study of mankind is man, and this precept should receive recognition in any liberal system of engineering education. Exclusive concentration on the materialistic and scientific aspects of his profession tends to produce in a student a certain narrowness of vision which subsequent experience may never wholly rectify. Too often one encounters the young man who assimilates with meticulous diligence every scrap of knowledge imparted to him, and in consequence passes all examinations with inevitable precision. His immediate advancement is thereby assured, and it is an absolute certainty that his diligence will carry him up to a certain level; but it is more than likely that lack of humanity and breadth of outlook will put a limit to any further advancement. At the time when his mind was most susceptible to treatment, his root development has been stunted by an over-indulgence in an ill-balanced diet and a lack of those essential vitamins which the humanistic side of education alone can provide.

It is good to have communed with the great minds of the past, but that form of culture known as *literae humaniores* is a luxury which, in the case of an engineering student, must be left to individual enterprise, and the humanistic side of engineering education must perforce relate mainly to the present and the future. Engineering is now shaping the destiny of civilisation; it has vast potentialities for both good and evil and, side by side with his scientific training, a student should have his interest stimulated towards the humanitarian, the economic, and even the ethical responsibilities of the profession he is about to enter.

Examinations

So far I have avoided the subject of examinations, but no talk on education can ignore completely this somewhat painful topic. A sweeping condemnation of the whole examination system is an easy way of gaining the approbation of one's audience; but, whilst I share the widespread mistrust of examinations as the ultimate test of mental ability, I mistrust even more the intellectual capability of the young man who fails with monotonous regularity to surmount every examination obstacle placed in his path, and in spite of all special pleadings, I consider the inference to be drawn from oft-repeated examination failures is all too obvious. It is easy to condemn the examination system, but even its most bitter critics have no clear-cut alternative to suggest. Written testimonials are of value, but only if one is in a position to assess the veracity of the writer, since writers of testimonials have this in common with those who inscribe epitaphs on tombstones, that they are not on their oath. Unless a testimonial is almost fulsome in tone it is apt to be interpreted as damning with faint praise; consequently there is a tendency to depict all geese as swans or, at any rate, birds with very elongated necks.

There is no doubt, however, that education, particularly in Great Britain, suffers from a surfeit of examinations. Teachers have their merits assessed by the examination successes their pupils achieve; consequently they tend to keep their eyes focused on the examination syllabus, education degenerates into mere instruction, and instruction in its

* Excerpts from the Presidential Address to the Institution of Civil Engineers.—Nov. 4th.

turn sinks to the yet lower depravity of cramming. But examinations, provided that they do not persistently obscure the view and terrorise their victims, do serve a useful purpose, and if they were eliminated, although a few ardent spirits would doubtless continue to seek knowledge for the joy of doing so, I fear that, on the part of the majority the pursuit would be but a half-hearted and poorly attended hunt. The main purpose of examinations is to find out if a student's knowledge has become available for export. It is all too easy to satisfy oneself in this respect, but mastery over a subject has been attained only when one is able to expound its meaning and applications to someone else. Viewed from this standpoint examinations cease to appear as vindictive impositions, to be circumvented with the minimum of effort. When one has reached that regrettable state of seniority which confers freedom from this particular infliction, the need of an examination substitute often becomes apparent and, for my own part, if I want to acquire a working knowledge of some unfamiliar subject, I put myself down to give a course of lectures thereon.

Workshop Training

The prominence which should be given to workshop practice in the case of a university student has often been the storm centre of heated controversy. Most certainly some such training of a preliminary character is essential, but it is not the primary duty of the universities to turn out skilled mechanics; they have neither the facilities nor the time for doing so, and the major part of this training must be post-graduate. Before a student takes his final examination he should, however, have achieved some familiarity with and some dexterity in the use of tools, and this qualification can be attained by workshop courses in the university or, alternatively, by experience in commercial workshops during vacations; usually a combination of these two alternatives is advisable. There is also much to be said for a short workshop training sandwiched in to a period between leaving school and entering the university. The manual dexterity a student acquires in such a course is of secondary importance; its primary value lies in the lessons in human psychology which this experience will consciously or subconsciously provide. The student may be too young to appreciate fully at the time the value of these lessons, but nevertheless youth to him at that stage is a great asset. He will, in consequence, find the workmen fatherly and helpful, and he will discover that they have a kindly and generous side to their nature which he may perhaps never fully appreciate if his first contacts with British workmen are delayed to a later stage.

Apart from the foregoing considerations a short interregnum between school and a university is excellent for character formation. It develops in a young man the knack of throwing out new roots in unfamiliar surroundings. Furthermore, it gives him the feeling that he has started his professional career and, in consequence, he does not enter the university regarding it as a school with a relaxed discipline.

To get the maximum benefit from this preliminary practical experience, respite from systematic tuition in theory may for the time being be permitted. But, if this is done, the time should not exceed six months; otherwise a student's sensitivity towards book learning may receive a setback which is more than temporary.

Drawing-office Training

Drawing is another educational subject to which, in a university education, a time limit has to be imposed. The first-class draughtsman is the outcome of years of practice and experience, and a university course which specialised on this product would have time for nothing else. At a university a grounding in drawing-office methods and considerable practice in solving engineering problems by graphical processes should be given; but, though the technique of high-class draughtsmanship ought to be set before students as a goal to be subsequently attained, they cannot be expected to reach this standard of perfection in the limited time available. A taste for the actual process of drawing is a very valuable asset, and an engineer who has never developed that taste, or has allowed it to fall into disuse, places himself at a disadvantage. Handing over a rough sketch to a draughtsman may produce one solution of a problem, but there is no assurance that it is the best. Work on a drawing board is a slow process which gives plenty of time for thought and, as the design begins to unfold various alternatives will almost inevitably present themselves and, more often than not, the final solution has little resemblance to the original conception. Hence I would advise any young engineer to cultivate a taste for drawing; to regard it as a valuable accomplishment and not as a menial task associated with the less exalted stages of an engineering career.

Research and Post-graduate Training

The word research in its application to engineering can produce mixed emotions. It can conjure up the soul-stirring contributions to knowledge made by great scientists such as Newton, Clerk Maxwell, Rutherford and J. J. Thomson, whilst at the other end of the scale there is the dreary vision of research being basely used as a means of obtaining a cheap degree. Without any disparagement to the great pioneers of the past, it should be recognised that outstanding distinction in research is becoming increasingly difficult to achieve. The days are past when nuggets could be found lying about; the alluvial deposits have been worked out, and to add to our stores of knowledge deep-level mining is generally essential. Consequently, in engineering research, team work is tending to replace individual effort, with the result that personalities have less opportunity of becoming conspicuous. This tendency must, sooner or later, be recognised in the training for research and in the granting of research degrees. Often the best approach for a beginner in research is to serve an apprenticeship in a team already at work, but under present circumstances this course may seriously jeopardise his chances of a research degree. For this particular hall-mark a premium is placed on individual effort and originality; consequently the young research worker who has his eye on a degree is generally forced to plough a lonely and often shallow furrow, instead of digging deeply into some problem of first-rate importance, guided and stimulated by a band of fellow-workers. Unless this trend is recognised, and the value of team work is taken into account in granting degrees, the training in research for university engineering students will become increasingly limited in scope and out of touch with modern methods.

The Locomotive in Mechanical Engineering*

No. III

(*Continued from page 312 November 7th*)

Future Position

I DO not wish to assume the *rôle* of prophet and venture an opinion as to where future development will lead, but rather will confine myself in this final section to consideration of some only amongst the many problems which will have to be solved.

As I have already explained, it is hoped that much more exact experimental data will be available after the war, and the problem which arises is how these data are to be interpreted and applied. The first and obvious move is to review the existing locomotive stock, with a view to deciding how far its level of efficiency can be raised. The reason why more has not already been done in this direction is that hitherto it has been difficult to justify, on any reliable basis, the cost involved. A second reason is that, in certain cases, operating conditions impose a lower standard of efficiency than that obtainable on test.

Mechanically, almost all the older types of engine are capable of being "tuned up" to some extent; and if opportunity is taken of the periodical complete renewal of major parts, then modifications to cylinders, valve events, and boilers need not be an expensive matter. Economically, however, the alterations may not be so easy to justify, and in this connection I shall cite a simple example. Careful testing may indicate that an alteration costing £200 to each of 100 engines will save £50 per annum in coal for each engine. Accordingly, the investment is authorised, the £20,000 is spent, and in due course the directors begin to inquire if the promised saving has been realised. Coal statistics on British railways are worked out on the basis of pounds per mile run, and if, as is often the case, there has been in the intervening period a considerable variation in traffic conditions, such as a revival in trade, calling for heavier train loadings, or a new time-table involving a general speed-up, these factors may increase the coal consumption per mile more than the locomotive improvement will reduce it. The net result is that there is no apparent saving, as shown by the usual statistics, and when this happens the effectiveness of test results are sometimes called in question.

The testing, however, is perfectly sound, and what is lacking is means of checking in service whether the promised results are forthcoming or not. This raises the question as to whether the wise investment of capital in motive power improvements will not call for some alteration in the basis on which annual statistics are compiled. Unlike electric traction, the power consumed with steam operation is not readily ascertainable from day to day, and some basis of ton-miles with a factor for speed of operation seems to be needed as a divisor into the total quantity of fuel consumed.

A second point concerns the conditions

* Institution of Mechanical Engineers. Address by the President, W. A. Stanier, M.I. Mech. E. Slightly abridged.

under which the engine is likely to work. There are thousands of engines in the country employed on shunting and short-distance freight work, where conditions of maximum tractive effort at very low speed are continuous. The reciprocating steam engine is very suitable for this work from a practical point of view, because it provides this requirement without the need of transmission gear of any kind. But unless the engine is to be of undue size, these conditions call for full-gear working, in which the steam is not used expansively; and if this is the normal condition, the question may be asked, What use is it to apply improvements which will bring economy only when the engine is working expansively? Moreover, the rebuilding of existing engines, at one time popular, is no longer so prevalent. It is possible for the addition of some improvements to act like new wine in old bottles, and cases may be cited in which new and improved cylinders and valve events may cause continual trouble in bearings which were of inadequate size even for the original state of the engine. Thus caution has to be observed in the realm of alterations to existing engines; but, when all is said, on balance there is probably a great deal to be obtained from an intensive study of this matter.

. 10—Union Pacific Turbo-Electric "Steamotive"

Whatever is done regarding the existing stock, sooner or later a choice has to be made of the form of new motive power to be built in the future. In advancing from the known to the unknown, controversy seems inescapable, and the claims of electrification, diesel power, and turbo-condensing steam units will vigorously contest those of the normal steam locomotive, improved as far as it is possible to go. The problem is an engineering one, it is true; but to an equal, if not greater, extent it is a financial and an operating problem. Departure from the conventional form in nearly all cases gives rise to increased first cost, and therefore to increased capital charges. If the savings due to lower fuel consumption are to remain as a net gain, some decrease in other operating costs and in repair costs is essential to offset the capital charges referred to.

The mileage run thus becomes a vital factor, and this is limited partly by the engine's ability to attain a sufficient mileage per day, and partly by operating considerations allowing of that mileage being run. Each locomotive available for work on the London Midland and Scottish Railway is called upon to run an average of only 100 miles per day. This is not because 100 miles is the maximum distance a steam locomotive is capable of running—an example has already been cited of an 800-mile run in the day—but it is due to the fact that varying density of traffic on different lines, and fluctuations in demand between night and day, mid-week, and week-end, make it difficult for rosters to be worked out which will enable the engines to run on the average more than this distance. It is clear therefore that for many turns of duty the time required by steam locomotives for examinations, washouts, &c., is not a limitation to the building up of mileage, since the mileage could not be provided anyway for traffic reasons—at any rate under present conditions. In such cases the normal steam locomotive, cheap in first cost, has not yet reached the limit of its exploitation. In the other cases, also numerous, where schedules call for, or can be made to call for, more intensive working, the more expensive diesel or condensing steam units offer themselves for serious consideration, and are attractive in proportion as they are able to offer more continuous availability than the best normal steam engines. As complete electrification calls for still higher capital charges, a total recasting of schedules and rosters to promote intensive usage is necessary, and is invariably undertaken.

The best normal reciprocating steam engines already referred to have hitherto been able to offer a steadily increasing availability and mileage between the intervals during which it is stopped for repairs in the shops, and we may hope for further advances as a result of better axle-boxes, harder tyres, and improved boiler materials and design. The alternative forms of motive power can in varying degree exploit the possibilities of totally enclosed working parts running in oil, rotary instead of reciprocating motion, perfect balancing, rapid replacement of complete units, and (in special cases) one-man operation. In this connection, a modification of the steam locomotive which has attracted some attention on the Continent and in America is the use of a number of small high-speed totally enclosed reciprocating units, individually geared to the driving axles. In such designs the limits placed by the loading gauge on compounding disappear, while the moving parts—running in oil protected from dirt and grit—may be expected to reduce the incidence of repairs. It would appear, however, that this arrangement can effect nothing which the steam turbine cannot do as well or better.

In the range where it can be bought and paid for by the possibility of lower operating costs per mile, increased thermal efficiency is the next step forward, to consolidate the first steps already taken by pioneers of the various means to that end. Theoretically, the advances already made in other fields make a similar advance on the part of the locomotive overdue, but practically there are some very real obstacles.

In steam propulsion condensing is the chief of these. Unlike the marine plant with the whole sea to draw on for cooling water, and the land installation with its adjacent river, and limitless space for cooling towers if required, the locomotive is very restricted in this respect. To carry the necessary cooling water and dissipate the heat therefrom, or alternatively to provide sufficient surface for direct air cooling, the locomotive can offer a space and weight varying from that of the existing tender to, at the very outside, the 9ft. by 9ft. by 60ft. and 100 tons weight represented by a vehicle with two six-wheel bogies. This is not necessarily impossible and invites ingenious design, but if the power required for the cooling fans is a high percentage of the total power output, as has usually been the case in attempts up to the present, a good deal of the advantage of condensing is lost.

Higher steam pressures call for water-tube boilers, of which many types are applicable to the locomotive if oil fuel is used. The number of types, capable of high capacity with small weight and space, which can use coal is much more restricted. The conveniences of using oil fuel are many, but both from economic and national points of view the use of the abundant and cheap supplies of British coal is very desirable, and the development of a coal-fired high-pressure water-tube boiler weighing about 60 per cent. of the weight of a locomotive type boiler of corresponding output is a problem yet to be solved.

Apart from various uncompleted or obsolete examples to be found on the Continent before the outbreak of war, the only really modern attempt to build a high-efficiency steam locomotive is the "Steamotive" of the General Electric Company of America, shown in Fig. 10, which embodies a water-tube boiler with a working pressure of 1500 lb. per square inch and a steam temperature of 920 deg. Fah. The design employs forced circulation, high gas speeds, turbo-electric drive, and condensing apparatus. Results with this engine will be awaited with interest, as offering a lead to our own future development. It has, however, the drawback (from the point of view of this country) of using oil fuel, and the same, of course, may be said of the highly developed diesel-electric express passenger engines which are now obtaining such a vogue in America.

It is clear that the locomotive engineer of the future will have to range far outside the limits of his railway surroundings, and a wide knowledge and understanding of what is going on in other fields will be essential. For this purpose the work of the Institution is invaluable, and it is hoped that as the locomotive follows the marine engine and the power station into the field of scientific investigation, the Institution may be the medium through which the various forward steps will be recorded, criticised and encouraged.

A Blind Engineer's Achievement.—A remarkable story of a blind man's victory over his affliction is told by Mr. K. W. Mason in the *Journal* of the National Institute for the Blind. Some time ago Mr. Mason, a chemist and engineer in a vulcanite fibre factory, lost his sight by an accident. To-day he is mill manager, and handling a wide range of orders, which include many for aircraft parts. Before he was discharged from hospital Mr. Mason had mastered Braille, and later he adapted the system to factory processing and records. His method enables him to state the exact position of any order within a few seconds. To help Mr. Mason with the many calculations connected with his work, the National Institute has Brailled a comptometer which can be read by touch. With this instrument he can readily deal with any sort of multiplication or division. He merely turns a wheel and the answer appears in Braille.

Technical Education in the U.S.S.R.

By W. R. STOKER, B.Sc. (Eng.) Hons.

IN view of the magnificent resistance now being offered by our Soviet ally to the forces of Nazi agression, the moment seems opportune for a description of the methods of training given to the numerous specialists required in the U.S.S.R. for the recent rapid development of industry. This can perhaps best be accomplished by an account of the work of a particular Soviet technical college, the Moscow Power Institute (M.P.I.), typical of the rest.

In the U.S.S.R., pre-school training of children commences in the day nurseries and kindergartens. Regular schooling, which is universal and compulsory, may take place in a seven-year school (8 to 15 years) or a ten-year school (8 to 18 years). Promising students from the seven-year schools are transferred to the ten-year schools.

Organisation

Universities are self-governing bodies, as distinct from the technical colleges, which offer technical education of a corresponding standard, but are under the direct control of various Commissariats, *e.g.*, the Commissariats of Communications, Railways, Heavy Industry, Machine Construction, Electrical Industry and the like, and which prepare specialists for their own needs. Questions common to all these institutions are dealt with by the Higher Schools Committee, which is directly responsible to the Government, the Council of People's Commisars.

Entrance

Entrance to the colleges is by examination, exemption from which, together with a prior claim on vacant places, is allowed to students from the ten-year schools who have attained the mark of "Excellent" in specified subjects of their school-leaving examinations. It would seem to be the case that whilst the theoretical training of a Soviet first-year man is about the same as that of a student of a British University, their practical knowledge and engineering sense is rather less than that of their British counterpart.

Programme

In the case of the M.P.I., which is typical of most other colleges, the degree course was of five years' duration. During the first two years the students covered much the same ground as a British intermediate course.

The training of the next three years was different in aim, scope, and character from that of a British university course. The object was to train engineers for specific jobs in specific factories or organisations. The schooling itself was free; indeed, the students were paid a subsistence allowance, varying in amount according to the year of study and the ability of the student. The student spent two or three summer vacation periods in factories, and at the end of the third year a decision had been reached, with the student's collaboration, concerning the plant at which the student was to work on completion of his five years of studies. There he was obliged by law to work for two years, and his degree was not granted until he had done so.

All this had considerable influence on the subjects and methods of study. In a British university, for instance, an electrical engineer may be called upon to study surveying, or may be able to substitute hydraulics for mathematics after his first year. In one particular British university, at any rate, there is little differentiation between civil, mechanical, and electrical courses until the final year. Even then there is not a great deal of differentiation between the two grades of electrical engineering training—communications and heavy.

In Soviet colleges there was much more specialisation, and the standard attained in the chosen subject was a good deal higher than in Britain. In the M.P.I. a student specialised in his last two years in one of the faculties, such as Machine Design, Illumination, Transmission, Generation, Telemechanisation, Application of Electricity to Industry, and so on. There was much in common between the various courses, but considerable differentiation. Electrical machines lectures were read at greater length to Design students than to others, Generation students received more hours in Thermodynamics.

This specialisation was facilitated both by the student's foreknowledge of his future work and by the fact that the colleges, themselves specialised by Commissariats, were of greater size than is common here. M.P.I., by no means the largest of engineering colleges, was controlled by the Commissariat for the Electrical Industry, and trained only electrical engineers for that Commissariat. It had about 4000 students, and there were similar colleges in Leningrad, Tomsk, Sverdlovsk, Tbilisi, Kharkov, and Kiev. Electrical engineers for other industries were trained by the colleges of the Commissariat of Railways, of Communications, and elsewhere. The main electrical factories in Moscow manufactured transformers, D.C. machines, meters, lamps, and some general A.C. machinery, so that M.P.I. tended to specialise on these subjects. Leningrad produced turbo-generators and automobile and tractor accessories, and so on. Hence, the colleges of different cities all had local trends. These trends were not narrow, however, for M.P.I. students went to Leningrad, Kharkov, and even Caucasian factories and power plants for training. There was also considerable interchange of experience between the various colleges by visits of lecturers and by conferences.

Methods of Teaching

Methods of teaching were advanced. A course of lectures might be preceded by a visit to the relevant laboratories, with demonstrations, whilst numerous practical demonstrations were staged during the lectures. Special hours were set aside for question and answer between students and lecturer. It was customary for a junior lecturer in training to be on duty in the department at various hours of the day ready to answer any questions or to enter into technical discussions with students. Many of the courses were illustrated by films. M.P.I. made many of its own films, which were edited by senior lecturers and manufactured by a special department of the Institute. There were films on the theory and manufacture of induction motors and transformers. An interesting film dealt with surge phenomena in transformers, and showed black and white diagrams of surges travelling along a transmission line and striking a transformer, with the resulting reflections and oscillations. The uses of surge arresters and Petersen coils were illustrated and the design and construction of Soviet non-resonating transformers was shown. There was even a film on vector algebra and calculus making clear by black and white drawings of vectors and planes the meaning of potential fields, divergence, vortices, vector potential and the like.

Examination

Examination procedure in the U.S.S.R. was unique. There were no written examinations; all were oral. Before proceeding to his theoretical examination in any subject the student had first to obtain his laboratory pass. This implied that he had worked in the laboratories for a certain number of hours, had executed a basic number of experiments and written them up. Further, he was obliged to satisfy the laboratory assistant tutor that he understood the work. The terminal examinations were organised by the College alone. Yearly, and particularly final, examinations were State controlled. The actual examining was carried out by the lecturer in the given subject and by one or two of his assistants, all of whom were familiar to the student. They examined students simultaneously in the same room under the supervision of representatives of the Commissariat and of the Higher Schools Committee. The student was given a list of one to three questions, was allowed up to half-an-hour for preparation and then expounded his answer to the examiner. Generally, he was also questioned by one of the State representatives. The marks were "Excellent," "Good," "Satisfactory" or "Unsatisfactory," as the case might be. However, the degree was not granted solely on the basis of theoretical examinations. The student was given or chose a suitable theme and had to prepare a "Diploma Project." This might be a design, say, the design of a transmission line between two points, or a small item of research required by a factory or some subject of a similar nature. The research work was carried out in the Institute or in factory laboratories. The student was given a period of, say, three months in which to draw up a report on his problem; he might refer to any sources he liked, but he had to produce a finished job. This was read to an Examination Committee representing the Institute and the State, and this Committee made its recommendations to the Commissariat which awarded the degree.

The Students

The students themselves were serious workers, but this did not prevent their active participation in sports, such as skiing, mountain climbing, flying, and parachute jumping, in which there were special lecture courses, and holiday camps. There were Institute teams for volley ball, basket ball, tennis, water polo and other sports. Inter-college athletics were organised; chess was also very popular. There was an orchestra and amateur theatricals. The latter was on occasion combined with the students' language lessons for the production of an evening's entertainment entirely in French, German and English. On such occasions it must be admitted that the students understood their own variety of English pronunciation better than the present author did and also better than the author's speeches in his native tongue. Nevertheless, it was all good fun.

In the M.P.I. about 80 per cent. of the students graduating were men and 20 per cent. women; in some medical colleges these proportions were almost exactly reversed. In M.P.I. a greater proportion of women than men failed in their first-year examinations, but there did not seem to be any feeling against women as such in engineering, and they successfully graduated in all courses

from illumination to machine design. The students were mostly Russians, but nearly all the principal nationalities of the U.S.S.R. were represented. It could not be said that Mongols, Tartars or Ossetians showed any less ability than the others and the complete absence of colour feeling was remarkable. It was not uncommon for students to be married and have children of their own, whilst among post-graduates this was the rule rather than the exception. Often both parents studied, the wife occasionally being more advanced than the husband. The student hostels had special quarters for married folk and day nurseries for the children. Medical treatment was free for all. The Institute was annually allotted a number of places in sanatoria around Moscow, in the Crimea or the Caucasus, to which students in poor health were sent. Places in rest homes were allotted to capable students. The Institute had a regular canteen and a "dietetic" canteen serving special food under doctors' orders. There was a large library from which the students could borrow textbooks or novels and which took in a considerable number of Soviet and foreign journals.

Post-graduate Training

An organised system of post-graduate training existed primarily to provide academic staff for the educational institutions of the Commissariat concerned, but also to prepare research workers and other highly trained specialists. The State degree of Candidate of Science was received at the end of a three-year course.

Entrance

For admission to these courses it was necessary to hold an Engineer's Diploma, and to have completed at least two years' practical work in a factory, where sufficient ability must have been shown. An adequate knowledge of Russian was obligatory. In other colleges in parts of the U.S.S.R., with national languages other than Russian, teaching was in the native tongue and Russian was a compulsory second language. The post-graduate received a subsistence allowance comparable with the wage paid to an engineer in a factory and living quarters were provided at low rents.

Application for admission was made to the Education Department of the Commissariat concerned, and had to be accompanied by recommendations from the manager of the employing factory and from the lecturer who was to be the student's "leader."

The leaders were professors, senior lecturers of the college, or occasionally workers from allied research institutions, and were generally specialists in some line or other. In the Machines Faculty of M.P.I., for instance, one leader was a professor and academician, another a professor and consulting engineer to the transformer works, another a D.Sc., lecturer and consultant to an induction motor factory. Each leader had three or four post-graduates.

Programme

During his first year the post-graduate attended courses of lectures. In the case of M.P.I., all took a refresher course in mathematics, covering infinitesimal calculus, continuity of functions, convergency of series, differential equations, and the like. There was a compulsory course on the History of Philosophy, leading up to an elementary knowledge of dialectical materialism. Two foreign languages were required. The remaining subjects varied from student to student, details being decided after the thesis subject had been chosen and rectified. In the case of the author, whose thesis dealt with transformer design, these were as follows :—

Mathematics.—Multiple differentiation and integration ; differential equations of vibrating strings (wave and telegraph equations) ; functions of complex variables ; vector algebra and calculus, elementary tensors ; solution of differential equations by operator methods (Heaviside).

Physics.—Molecular and atomic physics and matter leading up to this ; physics of magnetism, including electron spin and domain theories ; physics of insulating materials, breakdown, &c.

Electro-technology.—Electricity and magnetism in terms of vector algebra and calculus ; transient processes in electric circuits treated by Heaviside methods.

Special Subjects.—Surges in transformers (based on Bewley's "Travelling Waves in Transmission Systems") ; electro-magnetic. theory (based on Hague's "Electro-magnetic Problems in Electrical Engineering").

These books and many others by British, American and German authors as well as many good books by Russian authors were available cheaply in Russian, an allowance of 100 roubles a quarter being made for the purchase of books and journals.

Method

The method of study was tutorial, meetings with the tutor being arranged once a week for a couple of hours. The physics tutors were on the staff of the Moscow State University, the author having the good fortune to be allotted to a leading research worker on the physics of magnetism in that University. The fundamental idea behind the training was that the post-graduate should learn to read for himself and only take his difficulties to his tutor. Examination, pass or fail only, was oral. In the case of the special subjects the examination consisted in having to deliver a lecture of some twenty minutes on certain aspects of the subject to an audience consisting of the leader, the tutor and anyone else interested. Three or four days for preparation was allowed. Discussion had to be answered. All this part of the course was covered in about 2½ years.

Training in Teaching and Research

By the end of his first six months the post-graduate had to be ready to take students in the Institute laboratories. Towards the end of his course he also had to examine the students first on their laboratory work, later on their theoretical work. He might also be called upon to deliver one or two of the lectures in his leader's course under the leader's supervision.

During the first year the post-graduate was familiarised with methods of research work by working on one of his leader's research subjects. By the end of the first year the subject of his own thesis was chosen and ratified and he would set to work on it.

The Thesis

Presentation of the thesis was the culmination of the post-graduate training. The thesis had first to be approved by the Faculty, then "Official Opponents" were appointed and supplied with copies of the thesis, which also had to be available for inspection in the Institute library. The thesis was then read before an audience consisting of the leader, the opponents, representatives of the Commissariat and the Higher Schools Committee, representatives of factories interested in the subject dealt with, and any others who cared to attend. The function of the opponents was to lead the discussion, which was generally lively. The post-graduate would sum up and reply to the discussion. The leader made a short speech on the candidate's ability and work. If everything went according to schedule the thesis was sent to the Commissariat and the Higher Schools Committee, together with the recommendations of the Examining Committee, and the degree was finally ratified.

If the post-graduate failed to produce a suitable thesis in a reasonable time his stipend (but not his teaching pay) was cut off as soon as his three-year period was up. If there were signs that the thesis would not be ready in a further month or two the post-graduate was sent to work in a Junior Technical College and could present his thesis later. If the delay was too long he might have to take further theoretical examinations.

After Graduation

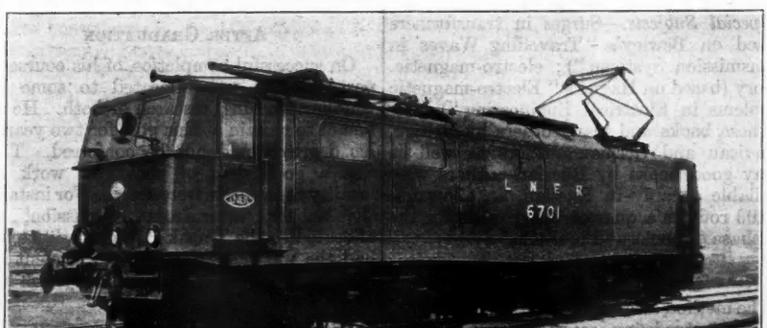
On successful completion of his course the post-graduate was allocated to some job, whether teaching, research or both. He was bound to remain at this post for two years or his degree would not be conferred. There was a good deal of choice of work and locality as lecturers were scarce. For instance, the author, after some discussion, was allocated to the Tomsk Power Institute, and had the war not intervened to prevent him presenting his thesis he might very well have been lecturing there now.

Teacher's Life

Some idea of the life of a Soviet technical college lecturer will have been obtained from the above. Another aspect, typical of Soviet methods, was the Faculty meeting. These meetings were held monthly and dealt primarily with "production problems." Plans were drawn up for future lecture courses and research work. There was plenty of opportunity for criticism of bad work, poor maintenance of apparatus or slacking, whether by professor or post-graduate. Lagging post-graduates were called upon to stand up and explain their backwardness. Joint work by several lecturers on common textbooks might be planned. Arrangements were made for lecturers to attend one another's courses. Representations made by the Students' Trade Union concerning the quality of lectures were gently brought home to the offenders and representatives of the students could attend to present the student viewpoint. A check-up might be held to see how the "Socialist Competition" between various faculties or different colleges was proceeding, or to see whether the lecturers were doing their gas mask training or voluntary rifle practice and fulfilling their other "social obligations." The proceedings generally concluded with a short technical paper dealing with original work or a summary of the foreign technical Press followed by a discussion. These meetings were lengthy, for Russians are fond of such occasions. They were often lively owing to the Soviet encouragement of internal criticism. Any attempt to "get back" at a critic was very sharply dealt with. On one celebrated occasion a respected D.Sc. was even known to stamp out of the room, but the proceedings were generally witty and good natured. Occasionally a learned academician would celebrate his fiftieth anniversary of teaching, or a record number of post-graduates would complete their course or perhaps we would be awarded a "travelling Red Banner" as the best Faculty of the Institute. Such occasions were celebrated by the consumption of ham sandwiches and iced cakes washed down with beer and even a little wine or vodka. They were happy days, rich in opportunity for productive work. May their like soon again return to our Soviet colleagues.

Mixed Traffic Electric Locomotive

IN an accompanying diagram and engravings we illustrate a mixed traffic electric locomotive which has just been completed for future service on the Manchester-Sheffield-Wath electrified line of the L.N.E.R. This locomotive is designed to handle a wide range of traffic, comprising main line passenger and express goods trains at speeds up to 65 m.p.h., the haulage of heavy mineral trains over the Pennines, and the working of other services with local passenger and goods trains. In order to meet these varied service conditions it was decided that an articulated double-bogie arrangement should be adopted. The locomotive has a bogie design which embodies special springing; electrical compensation for the weight transference that occurs on starting; regenerative braking; and an electrically heated boiler for steam heating of trains. The leading dimensions are shown on the diagram, and the main particulars are given in an accompanying table.



1360 H.P. MIXED TRAFFIC ELECTRIC LOCOMOTIVE

Mechanical Parts

The steel body and underframe, containing the electrical and auxiliary equipment, are supported on two articulated four-wheel bogies which carry the draw gear and buffer gear. The interior of the body is divided into seven compartments, consisting of two driver's cabs, two auxiliary machine compartments, one resistance chamber, one H.T. control chamber and one boiler compartment. In the construction of body, underframe and bogies a certain amount of fabrication has been employed, but riveting has mainly been used. As stated above, each bogie has an individual wheel base of 11ft. 6in. and the total wheel base of the engine is 35ft. The wheels are 4ft. 2in. diameter and have outside journal bearings 6¾in. diameter by 12in. long. Bogie frames are 1in. thick. The outer drag boxes are formed of plate steel welded into the main bogie frame plates and on to the buffer beams. The inner drag boxes which carry a very substantial articulated coupling are steel castings. In addition to being articulated in the general sense of allowing the two bogies to rise and fall relative to one another and to allow for the negotiation of simple curves, one unit of the coupling has been given a certain amount of spring-controlled side translation to compensate for the relative movements on a reverse curve. The bogie centre stay is a steel casting, but as it does not take the upper structure weight at its centre it is of specially light construction. The weight on the axle-boxes is taken by one independent laminated spring over each axle-box, and, in addition, the upper structure is carried on four helical springs on each bogie in brackets fixed on the outside of the bogie frames. These helical springs each fit into an inverted cylinder, the upper portion of which is concave as the segment of a sphere. Between the cylinder and the bearing faces of the upper structure is interposed a washer having a convex surface equal in radius to the sphere. Articulating action between the bogies and upper structure to compensate for their relative angular movements is thus obtained. The inverted cylinders in their turn fit into the above-mentioned brackets on the bogie frames, and they are so arranged that the helical springs can be renewed at the running sheds without any lifting of the engine by cranes. The complete upper structure is therefore provided with eight points of spring support independent of the main laminated springs, and it is found that this arrangement gives good riding qualities. A certain amount of lateral side movement has

Particulars of Mixed Traffic Electric Locomotive "No. 6701"

Mechanical	
Length over buffers	50ft. 4in.
Width over body	9ft.
Height to top of pantograph locked down	13ft.
Total wheel base	35ft.
Bogie wheel base	11ft. 6in.
Minimum curve negotiated	5 chains
Total weight in working order	88 tons
Axle loading	22 tons
Wheel diameter	50in.
Electrical	
Nominal voltage (D.C.)	1500 volts
Number of traction motors	Four
Locomotive horsepower (one-hour rating)	1860 H.P.
Locomotive horsepower (continuous rating)	1360 H.P.
Normal starting tractive effort	38,000 lb.
Approximate maximum starting tractive effort	45,000 lb.

HEAD-ON VIEW

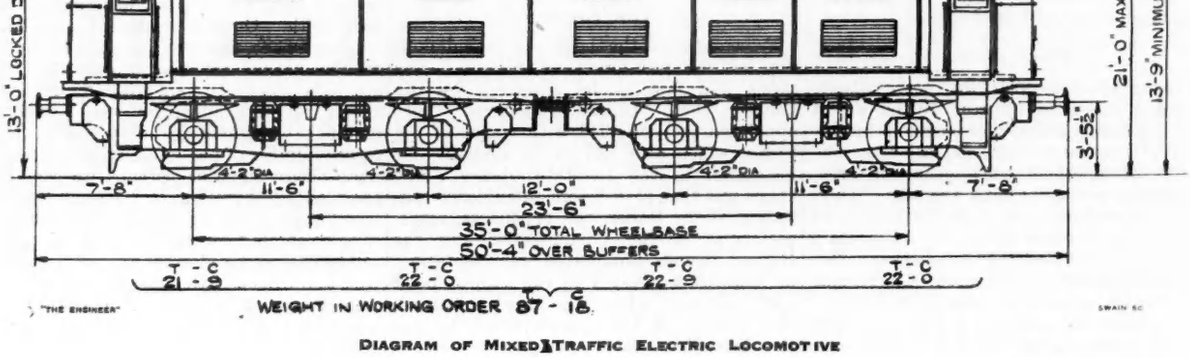


DIAGRAM OF MIXED TRAFFIC ELECTRIC LOCOMOTIVE

also been allowed for between the upper structure and the two bogies. The maximum is ½in. on either side of the centre and it is controlled by means of helical springs fitted within the main centre casting of each bogie in a similar manner to the side control springs of the conventional spring-controlled locomotive bogie. One centre casting is also provided with longitudinal clearance to allow for the alteration of the bogie centre distance on curves.

The base of the upper structure which forms the foundation for the machinery and control equipment assembled therein is formed of two longitudinal main frames, ¾in. thick and 1ft. 6in. deep at the centre. It is firmly braced by welded and riveted stays, one at the centre of the frame and one over each bogie centre. These stays carry longitudinal rolled sections from end to end of the locomotive to which the footplate is secured, and which carry the machinery supports. The stays above the bogie centres also have rubbing blocks transferring the weight of the upper structure on to the helical bearing springs previously mentioned. The basis of the cab and body construction is a series of channel iron car lines forming a frame on to which the roof and outer plates are secured. The framework also carries the weight of the two pantographs and their necessary operating gear. In order to keep the weight within the allowable limits the outer body plates are only ⅛in. thick; a slight curvature has therefore been given to the car lines and plating to prevent any drumming.

The locomotive itself is fitted with the Westinghouse brake, but it also has a motor-driven exhauster for operating the vacuum brakes on passenger and goods trains. A motor-driven compressor is therefore provided, and the compressed air is also used for operating the pantograph current collector and the electrical control. In each driver's cab there is a driver's brake valve, so designed that the air brake is applied to the locomotive and the vacuum brake is applied to the train simultaneously.

Electrical Equipment

The current is collected from the 1500-volt overhead line by either of two pantograph current collectors. Each traction motor is provided with forced ventilation and insulated for 1500 volts, but the motors are connected permanently in two pairs with 750 volts across the brushes of each motor. The motors are operated in series and parallel combination and four stages of field weakening are provided. To obtain steady control of the heavy trains on the down gradients from the Woodhead tunnel at the top of the Pennines the motors can also be connected for regenerative braking by separately exciting the fields from the motor generator mentioned below, and so return energy to the overhead line.

The remote control of the electro-pneumatic contactors and the drum type switches for reversing, &c., is carried out by 50-volt circuits from the master controller, and the low-tension supply for this purpose is obtained from a 5-kW motor generator blower set. A second motor generator blower set provides current for the excitation of the main motor fields during regeneration. The blowers of these two sets, which run continuously, give a combined output of 9000 cubic feet per minute for ventilating the main motors. In the event of the 5-kW motor generator failing there is a battery of thirty-three nickel-iron cells having a rating of 40 ampere hours, which would be able to provide current for lighting and control, and this battery is normally charged by the generator. The usual protective interlocking prevents access to the resistance and high-tension compartments when either pantograph is in the raised position.

Since passenger trains from all parts of the line will work over the electrified section steam heating is essential, and tests were carried out to ascertain the amount of steam required per coach. As a result it was decided that a boiler producing 750 lb. of steam per hour at a pressure of 65 lb. per square inch would be able to give all the steam necessary for the longest trains operated between Manchester and Sheffield. An electric boiler working at 1500 volts D.C. and rated at 300 kW with automatic control has therefore been provided.

When a heavy train is being started the large draw-bar pull causes a transference of weight from the leading to the rear axle of each bogie, and the resulting loss of adhesion might cause the leading wheels to start slipping if the tractive effort were not reduced on these two axles. Control is effected by the driver closing a small low-tension switch mounted near the master controller, which by remote control weakens the field of the leading motor on each bogie and so reduces its tractive effort. At the same time a red indicator lamp lights up to remind the driver to open the weight transference control switch and restore conditions to normal as soon as there is no longer need for the high starting tractive effort.

Trial Running

During a trial run on Friday, October 3rd, from Warwick Road to Altrincham and back, a distance of only 5½ miles with a passenger train consisting of seven main line coaches and weighing nearly 250 tons, a speed of 64 m.p.h. was reached in the outward direction and a speed of 60 m.p.h. on the return journey in spite of an intermediate signal stop. On Sunday, October 5th, further trial runs on this section of line took place with a goods train consisting of forty-five loaded coal wagons and two 20-ton goods brakes, making a total trailing load of just under 700 tons. A speed of 36 m.p.h. was reached with this load, and braking tests showed that this train could be pulled up smoothly from 30 m.p.h. to a dead stop within a distance of 600 yards in approximately 80 seconds.

New Iron and Steel Distribution Scheme

The Ministry of Supply, Iron and Steel Control, announces that (1) now that the principles of the iron and steel distribution scheme are well understood it is felt possible to reduce the clerical work involved by making it unnecessary for authorisations for iron and steel to be issued when placing orders for manufactured articles where the manufacturer would require 1 cwt. or less of iron and steel to execute each order. Manufacturers supplying such orders are instead invited to apply to the Board of Trade or the Ministry of Works and Buildings for a bulk authorisation, covering the iron and steel needed to execute such small orders. (2) When a bulk authorisation on Form M covering these small quantities has been obtained, authorisations for 1 cwt. or less of iron and steel must not be asked for, or, if received from any customer, must not be treated as valid and used to acquire iron and steel in addition to that covered by the bulk authorisation. Thus the bulk authorisation must be used to meet small orders irrespective of the Government Department or purpose for which the articles supplied are to be used. Where wholesalers or retailers fulfil small orders within the limit referred to they should not ask their customers for authorisation, but when ordering from their suppliers should certify the total quantity supplied under the small quantities limit. As the quantity of iron and steel available for bulk authorisation will be limited a responsibility will rest on retailers, wholesalers and manufacturers to see that small orders for articles containing iron and steel are only accepted for purposes which are essential and that the articles they supply are fairly distributed. (3) The Ministry of Works and Buildings will issue the bulk authorisations in the case of articles required primarily for the building trade (see Schedule attached) and the Board of Trade for other articles. Firms wishing to take advantage of these arrangements should apply to the appropriate Department for the form on which to enter the necessary particulars. In cases where manufacturers already receive bulk authorisations from these or other Government Departments covering all or part of their orders, they should not, of course, apply for any further authorisation in respect of small orders already covered. (4) These arrangements will come into operation as soon as the applications are received and the bulk authorisations are issued by the Departments concerned. In any case, it is envisaged that by January 1st, 1942, the arrangements will be in general operation, and it will not be necessary for Form M to be used in the case of small orders for manufactured articles. (5) It will be appreciated that the foregoing arrangements in no way relax the need for a person acquiring iron and steel (in the forms listed in the First Schedule to the Control of Iron and Steel, No. 15 Order) to obtain an authorisation. They do, however, provide for a bulk authorisation for iron and steel to be given to manufacturers in the cases referred to, instead of the manufacturers having to collect a large number of separate small authorisations from each of his customers.

The following is the list of goods for which the Ministry of Works and Buildings issue bulk authorisations. Applications should be addressed to the Secretary, Ministry of Works and Buildings (A.S. 69), Lambeth Bridge House, Albert Embankment, London, S.E.1:—Stoves, grates, ranges and cooking apparatus (solid fuel); oil heaters and cookers; cast iron hot water boilers (including gas-fired boilers used for central heating), radiators and radiator fittings; cast iron baths, sanitary cisterns and other sanitary cast iron and steel goods; galvanised steel rain water goods; pumps for domestic and agricultural water supplies; builders' ironmongery of cast iron such as gate fittings, door springs and checks, door bolts (wrought iron), door plates, door letter-boxes, handles and knockers, locks and hinges (except furniture locks and hinges and locks for cases), latches, hasps and staples, shelf brackets, other items of builders' ironmongery; steel scaffolding and fittings; steel flush pipes; expanded metal for goods for all purposes not covered by the Ministry of Home Security and not being machine guards, metal windows and window fittings, skylights, roof lights, ventilators and ventilator frames; exterior fencing; steel ladders for attachment to chimneys or buildings; cable racks and hangers; cowl ventilators; wall ties; slating clips and other roofing fittings; rolling shutters and fittings; sanitary fittings; gutter fittings; sliding door fitments; conduit fittings; iron and steel accessories for asbestos cement building materials; iron and steel reinforcement for pre-cast concrete products. Applications to the Board of Trade should be sent to the Assistant Secretary, Industrial Supplies Department, Board of Trade, Millbank, London, S.W.1.

The intention of the scheme is to extend the provisions for facilitating the purchase of small quantities of iron and steel to small orders for articles containing iron or steel. Thus a supplier of manufactured articles fulfilling orders, each of which involves only small quantities of iron or steel, but who buys appreciable quantities of iron or steel in the aggregate, will be able to obtain a bulk authorisation covering the tonnage needed and so avoid asking each of his customers for a separate authorisation. This logical development in procedure is designed to assist a wide range of producers of manufactured articles. Its success, which leaves so much to the common sense and co-operation of manufacturers and consumers, has already been proved by arrangements made by the Board of Trade in a limited number of cases. As much of the clerical labour involved in the preparation of separate small M forms will now be eliminated, it is felt that the new procedure will be welcomed by manufacturers and consumers.

The Eire Fuel Problem.—Eire, with a limited supply of anthracite coal from Castlecomer, has been trying peat charcoal for producer gas vehicles and Fufurol, a wheat-straw product obtained mainly from America, along with a fuel named Motol, said to be obtained by a new method of breaking-down coal. It is said that even under the best conditions the production of Motol would be limited to 1,000,000 gallons a year from home resources. So far, peat-charcoal experiments have not given satisfactory results, mainly because of tarry deposits in the engines, and because the fuel is inclined to crumble into dust through the vibration of the vehicle.

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THE RECONSTRUCTION OF OUR EDUCATIONAL SYSTEM

IT is abundantly evident that one effect of the war will be to compel us, whether we like it or not, to recast many of our treasured traditions, and much of our established practice, in the field of education. Powerful factors and influences are already at work which, when peace is restored, will result in important modifications being made in the organisation and outlook of our board schools, public schools, technical colleges, and universities. Some of the changes which will be made will doubtlessly be of a temporary character, and will be forced upon us by the general financial stringency and other hard facts of the immediate post-war reconstruction period. The problems presented by such changes, if they are approached in a liberal and sympathetic manner, will be satisfactorily solved by the passage of time. Higher problems, however, will also have to be faced. It is essential to recognise fully and in time that the civilisation for which we are fighting is synonymous with our national culture, and that our national culture is founded on our educational system. One object must be not only to reconstruct the educational edifice which the war in one way and another has so severely damaged, but to rebuild it in such a manner that our culture shall endure and progress. No greater tragedy can be imagined than that we should sacrifice so much to achieve the victory of our arms, only to find in a short time that the sagging of our culture had allowed German "kultur" once more to rear its ugly head in many parts of the world. If we are to win the peace which we so ardently desire, our culture must by its own unchallenged merits predominate over that of our present enemies. Such predominance will not be secured if we allow our educational system to stagnate or are content to see it merely recover the position which it occupied before war broke out. We must see to it that it is infused with fresh vigour and that, at whatever sacrifice of tradition or revolution of sacrosanct custom, it is adapted to discharge with high efficiency the duties which *our* new order will expect of it.

Our opportunities of advancing our educational system will be great, far greater than they were at the end of 1918. Then it was little more than a simple matter of routine to eliminate the disturbances caused by war conditions and requirements, and to resume teaching and instruction at the point at which it had been interrupted four years earlier. It is true that the war had brought an intensive development of scientific research, and induced among many educationalists an enhanced respect for the merits and value of a scientific curriculum. Nevertheless, there was little real impetus towards a new outlook on education and save in a few matters of minor detail, there was no general desire to introduce fundamental changes. Reconstruction of our educational system after the present war will be a widely different undertaking. Apart from the difficulties caused by the wholesale removal of instructors and students to distant quarters, reconstruction this time will involve literally the rebuilding of many of our educational establishments, and in numerous cases the restocking of them with equipment and books. While we cannot but deplore the damage which the enemy's bombs has done to our college and school libraries, laboratories, and lecture rooms, we must recognise that the destruction which has been wrought provides an opportunity which otherwise would not have arisen of planning improvements unhampered by the necessity for respecting the physical inheritances left us by previous generations. There is, however, another and even more important respect in which the opportunities open to us to-day are relatively much greater than they were twenty-three years ago. At the beginning of the earlier war, Germany was at the height of her reputation as a centre of intellectual achievement and instruction, while we were sunning ourselves in the light of our past achievements. Deliberately, as a matter of State policy, the rulers of Germany had for many years been fostering by every available means the development of the country's educational establishments, and in many branches of intellectual attainment German culture ranked high, and deservedly so, in the estimation of other nations. She had a lead, a long lead, over us in this matter. To-day, however, the Nazi Government has played into our hands. Deliberately, as an item of State policy, that Government has reversed the principle which guided the Hohenzollern rulers of the country. It has openly and forcibly sought to inspire, and has succeeded in inspiring, a contempt for intellectual attainment in the minds of German youths, and largely as the result of religious persecution has discouraged, discarded, or destroyed many of the country's leading thinkers and teachers. In the year in which Hitler came to power there were 150,000 students in Germany's centres of higher scientific education. By the summer of 1939 that number had shrunk to 60,000, although the area of the country had in the meanwhile been greatly increased. These figures were recently announced, almost with pride, by Dr. Mentzel, head of the science department of the German Ministry of Education. They illustrate forcibly the extent to which the Nazi's policy of intellectual suicide has already thrust towards a cultural collapse a nation once justly proud of its chemists, physicists, engineers, and medical workers.

There are many in this country who believe that our system of education as it had come to be established in 1939 after a long and arduous process of evolution is the best possible system, and indeed that no alternative system suitable to our national needs and characteristics is conceivable. A year ago we would hardly have dared to suggest to those who hold these conservative views that they should at least make themselves acquainted with the general principles of Russia's system of education, and particularly her system of technical education. To-day we can do so with confidence. The prolonged and fierce resistance which Russia has offered to the onslaught of the German mechanised hordes has revealed to the whole world not only the bravery of her people, but her true greatness as an industrial country. The immense battle which has raged along the Eastern front since July could not have been sustained by a country lacking vast manufacturing resources, and the will and the ability to develop them, or by a country whose educational system was inadequate to supply men of the right quality and in the number requisite for such development. Elsewhere in this issue the reader will find a first-hand account of the Russian system of technical education. At almost every point it is in violent contrast with accepted British practice and ideals, nor is it difficult to suggest several directions in which criticism might be levelled against it by educationalists indissolubly wedded to the British system. Nevertheless, whether we find it good or bad, wholly or in places, we cannot fail to recognise that the Russian system is not an idealistic paper scheme, but a carefully planned policy which has helped to raise the country in the course of a couple of decades from a backward to an advanced industrial status, and which has been crucially tested

in the fires of war. We are far indeed from advocating that it should be adopted in this country. We recognise that it is peculiarly fitted to the physical and political conditions existing in Russia, and that in several important respects it might prove a complete failure if it were introduced into a country, such as ours, which already possesses an elaborate educational system and an intensely developed industrial organisation. Nevertheless, it is worthy of our close study, if only for the sake of providing a counter to the views of those who maintain that the existing British educational system is as nearly perfect as it can be, and who argue in all sincerity that no practicable alternative to it can be proposed. When the war is over we will be compelled to reconstruct and rebuild our educational system. We must see to it that the natural desire to restore traditions and old-established curricula and customs is not allowed to thwart us of the great opportunity which we shall have of introducing changes that will advantage us in the post-war period.

American Aircraft Output

THE Press announcements which appear from time to time commonly put the prospective output of aircraft from the United States at so high a level that many readers will have wondered whether so ambitious a programme could be feasible. We are glad to be able to record that, according to information received, such an attainment appears by no means impossible; indeed, in part it has already been fulfilled. In April last we quoted in these columns the forecast made by Mr. T. P. Wright, engineering vice-president of the Curtis-Wright Corporation of America, that as many as 15,000 aircraft would be built in the United States by the end of this year. Figures now available show that during the first nine months of the year over 12,000 aircraft were completed, and that at this rate of construction the output by its end should be little short of 17,000, so fully meeting Mr. Wright's forecast. About half of these newly built aeroplanes were being allotted, it is said, to this country, but some may now have been diverted to Russia. How this output is shared between bombers, fighters, and training aircraft we are not precisely told, but during part at any rate of the period about one half were for training purposes and rather over half the rest were fighters. No doubt, future returns will show a gain in the proportion of bombers, especially those of large size. At the present time the monthly output of all types exceeds 2000—the rate with which, it seems, American opinion credits manufacture in this country. The United States authorities aim, we understand, at raising this to 3500 by the middle of next year, whilst the President himself has thought 50,000 a year a reasonable figure to work to, but may, it seems, now decide to go beyond it; so that German production, intense as it is, must be overwhelmed. Major-General G. H. Brett, Chief of the United States Army Air Corps, has recently estimated that most of the aircraft in the Middle East would soon be American. Germany has the opportunity of forcing on the conquered and occupied countries the task of aiding her in the production of warlike stores, but this can be no simple matter to arrange, since the risk of sabotage in manufacture is grave, and can presumably only be met by severely limiting production in such factories to simple parts which can be safeguarded by meticulous inspection. No doubt, however, this difficulty, serious as it may be, is little compared with the task the enemy has of providing adequately trained crews for his vast air fleets, especially in view of the loss of at least 20,000 aircraft in combat with the R.A.F. and the Russian Air Force.

Great assistance has been given to American output by the highly developed automobile industry, not so much by adapting existing plants to a new task—always difficult—as by undertaking the construction and operation of new factories suited to the new duties. This corresponds to the "shadow" scheme so largely in operation in this country, where even the longest established aircraft manufacturing firms are willing, on occasion, to admit that on the single score of output efficiency the "shadow" may have even more grip than what may, by courtesy, be called the "substance." The difficulty of changing over an existing mass production factory to a new type of product may be illustrated by a remark recently made by Mr. John D. Biggers, United States Co-ordinator of American and British Production. In the case of a large American motor-car company, which is turning over to the production of four-engined bombers, it will be necessary, according to Mr. Biggers, to spend 600,000 man-hours on design and 6,000,000 man-hours on tooling before production can start. One of the most encouraging features of the American situation is the decision of the great Ford automobile plant to make itself responsible for building complete "Liberator" bombers, a considerable undertaking, though not so strange to the Ford organisation as might be thought, since an offshoot of theirs—also in Detroit—set its hands to the construction of the largest kind of civil aircraft many years ago.

At one stage in the American programme a serious "bottle-neck" occurred in the provision of the immense number of engines needed—about 2½ per airframe. The engine parts were in general found to be too large to be made in automobile plants, and here the "shadow" method was especially effective, for the skill and experience of the automobile makers were more easily applied to the needs of the situation than were the plants they had previously operated. It is stated that by March last the engine output had risen to 2400 per month, and that by the time midsummer was reached, the "bottle-neck" had been almost, if not quite, removed. Some of the engines are to British designs and some to American. So far as other accessories are concerned—radio apparatus, for example—industry in America is easily able to handle the situation by the diversion of the appropriate manufacturing works from peacetime products to the requirements of to-day. We in Britain find ourselves fortunate that the delivery of this vast air fleet is substantially facilitated by the happily diminished loss of ships on the Atlantic crossing and by the ability of the larger aircraft to fly under their own power on this first stage of their long journey to attack enemy targets.

Obituary

FRANCIS ELIOT HOWARD

IT is with deep regret that we record the recent death, at his home, "Coleshill," Amersham, of Mr. Francis Eliot Howard, the chairman of Hayward-Tyler and Co., Ltd., of Luton. Mr. Howard, who was sixty-six years of age, was educated at Marlborough College, and was apprenticed as a civil engineer to the late J. Mansergh. Later he was employed on the York sewerage scheme and on the Birmingham water supply scheme at Rhayader. In 1906 he joined the firm of Hayward-Tyler and Co., Ltd., at Luton, and three years later he became a partner in the company. When in 1905 the firm was made a private limited company Mr. Howard was made a director and was appointed secretary to the company. In 1930 he was elected chairman of the company, a position which he held until his death. During his term of office he saw, in 1935, the works entirely reorganised, and its scope enlarged by the acquisition in 1936 of Electromersible Motors and Pumps, Ltd., as a subsidiary concern. In 1938 the company's pension scheme was inaugurated and the Hayward-Tyler Sports Club was formed.

He was an associate member of the Institution of Civil Engineers, a member of the Institution of Water Engineers, a Fellow of the Institute of Petroleum, a member of Council of the British Engineers' Association, and a member of the British Pump Manufacturers' Association. During his long career with the firm he was closely concerned with the selling organisation of the company, his earlier interests being with pumping machinery for water supply and sewerage undertakings, to which were added at a later date pumping plant for the oil industry.

The progress of the company and the welfare of the employees were always his especial concern, and at a time when industrial welfare is receiving the recognition it deserves he will be sorely missed. His advice or counsel was always available to any of his staff or workpeople who inquired of him, and his death at a comparatively early age will be deeply regretted by all who came into contact with him.

BOOKS RECEIVED

The Railways of Persia. London: *The Railway Gazette*, 33, Tothill Street, Westminster, S.W.1. Price 2s.

New Railway Network Principles. By J. F. Pownall. Birmingham: Cotterell and Co., 110, Dale End. Price 2s.

Simple Hydraulics for Firemen. By E. D. Grubb. Bristol: J. W. Arrowsmith, Ltd., 12, Small Street, Bristol, 1. Price 1s. 6d.

Fire Engineering Hydraulics. By G. O. Stephenson. Manchester: Emmott and Co., Ltd., 78, Palatine Road. Price 1s.

Economic Peace Aims. By Oswald Dutch. London: Edward Arnold and Co., 41–43, Maddox Street, W.1. Price 12s. 6d.

Press Tool Practice. By P. S. Houghton. Part I. London: Chapman and Hall, Ltd., 11, Henrietta Street, W.C.2. Price 13s. 6d.

Cofferdams. By L. White and E. A. Prentis. London: Oxford University Press, Amen House, Warwick Square, E.C.4. Price 50s.

Those Raw Materials. By C. A. Ward. London: George Allen and Unwin, Ltd., Ruskin House, 40, Museum Street, London, W.C.1. Price 15s.

The Aircraft Press Tool Maker. By W. S. B. Townsend. London: Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, W.C.2. Price 5s.

Modern Sanitary Engineering. By G. E. Mitchell. London: George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2. Price 12s. 6d.

William Gilbert, the First Electrician

By A. K. BRUCE

THE seventeenth century is renowned as a period of unique literary activity. It is not always realised that the same century stands equally unique as a period of momentous scientific progress. This is particularly true of scientific achievement in the British Isles, adorned, as is the seventeenth century, by the names of four outstanding men of science, William Gilbert, John Napier, William Harvey and Sir Isaac Newton. While the "Principia Mathematica" of Newton (published in 1687) is accounted the greatest scientific work of the century and possibly of all time, the first notable treatise on physics published in England appeared in 1600, and it is to the author of this treatise that the present memoir relates.

Towards the western end of Knightrider Street—which lies in the very heart of the City of London—there is a narrow descent on the south side which, for centuries past, has been called St. Peter's Hill. Prior to the construction of the modern Queen Victoria Street, St. Peter's Hill extended southward as far as Upper Thames Street, but the thoroughfare is now interrupted by the buildings on the south side of Queen Victoria Street, though part of the continuation to Upper Thames Street still exists in a *cul-de-sac* called Peter's Hill.

The name is taken from the long since vanished church of St. Peter Paul's Wharf, which, known in the twelfth century as St. Peter-the-Little, or St. Peter-le-Petyt, is now represented by a small churchyard on the north side of Upper Thames Street. It was on St. Peter's Hill (then known as Peter Lane), in a house called Wingfield House, that there dwelt, for many years, the celebrated William Gilbert (or Gilberd), justly celebrated as the founder of the science of electricity.

He was the son of Jerome Gilberd, Recorder of Colchester, and may have been born either at Colchester or at Clare, in Suffolk. Some doubt exists as to the exact date, though the late Professor Silvanus P. Thompson—to whom all admirers of Gilbert are so much beholden for information relating to the life and work of this great man—believed that Gilbert was born on May 24th, 1544. He even states the time as 2.30 p.m. Other evidence—notably the age and date inscribed on the contemporary monument in Holy Trinity Church, Colchester—would make the year of his birth 1540, and this date has usually been quoted. If it is correct that Gilbert was born in 1544, then he was fifty-nine at the time of his death, not sixty-three, as stated in the inscription on the memorial.

A house ("Tymperley's") still standing in Colchester is said to have been the one in which Gilbert was born, parts of it dating from the beginning of the sixteenth century or earlier. Certain it is that this house was his property, and much probability attaches to the belief that he may have died there.

Nothing definite is known of Gilbert's boyhood until the record of his matriculation in Cambridge as a pensioner from St. John's College (as "Gylbert") on May 24th, 1558. He proceeded B.A., 1560–61 (as "Gilbard"); M.A., 1564; and M.D., 1569. On March 27th, 1561, he was admitted (as "William Gylberd") Fellow of St. John's College on the foundation of Mr. Simpson, and on December 21st, 1569, he was admitted a senior fellow. On January 22nd, 1569–70 (as "William Gilberd"), he became senior bursar of the College, holding this office for one year, until January, 1570–71. It is commonly believed that subsequently to his residence in Cambridge and prior to his settling in London, Gilbert studied medicine on the Continent, doubtless at Padua, then the most renowned of medical schools, but no record has been found at Padua relating to his residence there.

Whatever may be the facts of his sojourn in Italy, Gilbert appears to have come to London in or about 1573. The exact date of his admittance as a Fellow of the College of Physicians is not known, the general belief being that he was enrolled about the time of his settlement in London. The "Roll of The Royal College of Physicians" (William Munk) shows that Gilbert was appointed censor in 1581, 1582, 1584, 1585, 1586, 1587, 1589 and 1590. From 1587 to 1594 inclusive and again from 1597 to 1599 he was treasurer. On March 3rd, 1596–97, he was elected consiliarius, occupying this office in 1597, 1598 and 1599. In 1600 he was president.

Gilbert was eminently successful in his medical practice, numbering among his patients Queen Elizabeth, to whom, in 1601, he was appointed physician-in-ordinary. On the death of the Queen in March, 1603, he continued, for a few months before his own death, as physician-in-ordinary to King James I. Greatly esteemed by Queen Elizabeth, there is a contested tradition that Gilbert had the honour of receiving her at the house in Colchester, to which reference has already been made. More reliable is the tradition in regard to the encouragement which, afforded by Queen Elizabeth, enabled him to concentrate on his scientific investigations. In this connection it is recorded that he founded a small society, which, meeting monthly in his house on St. Peter's Hill, London, held discussions on scientific matters. The little gathering may be regarded as the seed from which grew the Royal Society, though the discussions appear to have been discontinued when Gilbert's duties as physician to Queen Elizabeth caused him to remove to the Court.

Of more than topographical interest is the circumstance that St. Peter's Hill lies within a very short distance of the site (in Knightrider Street) of the house in which dwelt Thomas Linacre, sometime physician to Henry VII and Henry VIII, who with the valuable co-operation of Cardinal Wolsey, founded the College of Physicians and became its first President. This was in 1518, and the meetings of the College were held in Linacre's house until 1614, when the physicians removed to Amen Corner. Linacre—celebrated as a scholar and humanist as well as a physician—was the intimate friend of Erasmus, Archbishop Warham, Wolsey, Dean Colet, Grocyn, Tunstall and Sir Thomas More, all of whom were doubtless among his patients.

Civilised humanity will keep Gilbert in perpetual remembrance for his celebrated treatise entitled "De Magnete, Magneticisque corporibus, et de magno magnete tellure; physiologia nova, plurimus et argumentis et experimentis demonstrata," which, published in London during the year 1600, was the first great physical book produced in England. It contains 240 pages, and is now very scarce. Though reference to experiments with magnets may be found in the "De Rerum Natura" of Titus Lucretius Carus, who was active in the first century B.C., and in writings dating from the Middle Ages, Gilbert's treatise is justly regarded as the foundation of magnetic science, and he has the distinction of having proved that the earth is a natural magnet of stupendous size. "And this," remarks Sir Thomas Browne, referring to certain phenomena observed in connection with the magnetic needle, "was the invention of Dr. Gilbert, not many years past, a physician in London. And, therefore, although some assume the invention of its direction, and other have had the glory of the card, yet in the experiments, grounds and causes thereof, England produced the father philosopher, and discovered more in it, than Columbus or Americus did ever by it."

Numbered among the conspicuous scientific pioneers of all time, Gilbert has a peculiar claim to veneration in so far as he appears to have been the first investigator who systematically applied experimental methods to research in the physical sciences. The "De Magnete," in addition, laid the foundations on which, two hundred and twenty years later, Faraday, apprehending a fundamental relationship between electricity and magnetism, was to establish the mighty edifice which arose from the discovery of the induction of currents by motion of conductors in a magnetic field. "Before Gilbert," writes Sylvanus P. Thompson, "there was no electrician: he is the absolute founder of the science. And he claims our admiration, not only as the founder of the science of electricity, but as the founder also of another science, namely, that of terrestrial magnetism."

The great Lord Bacon, a contemporary and patient of Gilbert's, though his junior by some twenty years, regarded the "De Magnete" as an instance of extravagant speculation bottomed on insufficient data. This did not deter him from appropriating, without acknowledgment, whole paragraphs from "De Magnete." Bacon's judgment on the deductions contained in "De Magnete" was exploded long since by serious physicists, some of whom have deemed it appropriate to point out that such command as he had of the physical and mathematical knowledge of the sixteeenth century was not such as to entitle Bacon to criticise a philosopher of the calibre of Gilbert. Of sovereign authority is the opinion of the illustrious Galileo, who, writing of the English physicist, can "think him worthy of the greatest praise for the many new and true observations which he has made." Gilbert's masterly demonstration of the method of inductive reasoning was published twenty years before Bacon's "Novum Organum." Moreover, the Elizabethan physicist adopted the astronomical doctrine of Copernicus which Bacon rejected, and it is probable, indeed, that when Gilbert was born Copernicus was still alive. The celebrated treatise "De Orbium Celestium Revolutionibus," completed about 1530, was made public in 1540, the year in which Copernicus died, and the reputed year of Gilbert's birth. It will be remembered that the English physician is mentioned quite a number of times in the "Anatomy of Melancholy," where Burton, who had evidently studied Gilbert's writings, reveals himself as a not very enthusiastic follower of Copernicus. Gilbert, indeed, seems to have been the first man in England to recognise the scientific truth of what Copernicus taught.

Gilbert is believed to have laboured for about seventeen years on the researches and deductions which are embodied in "De Magnete," and the fact of his residence on St. Peter's Hill entitles this little thoroughfare to be regarded as the scientific shrine, *par excellence*, in the City of London. He died, unmarried, on November 30th, 1603, though whether in London or in Colchester

has not been established. It is usually supposed that he was buried in the chancel of the ancient church of The Holy Trinity, Colchester. There is, however, a long-established tradition to the effect that Gilbert died of the plague, which, in 1603, caused dreadful mortality both in London and in Colchester. Had he died in London from the effects of this terribly contagious disease, it is hardly credible that removal of his body for interment in Colchester would have been permitted.

Diligent examination of contemporary records has failed, however, to disclose any reliable evidence as to where Gilbert died. If it be a fact that he died, as has been supposed, from the plague, the manner and place of his interment would doubtless have been regulated by the statutory procedure in force at the time. It happens that under Orders given at Hampton Court on July 30th, 1603—four months prior to Gilbert's death—and "thought meete by his Majestie and his Privie Councell to be executed throughout the Counties of this Realme, in such Townes, Villages and other places as are, or may be hereafter infected with the Plague," it was enacted that there be appointed "some place apart in each Parish for the buriall of such persons as shall die of the Plague, as also to give order that they be buried after Sun setting, and yet nevertheless by daylight, so as the Curate be present for the observation of the Rites and Ceremonies prescribed by the Law, foreseeing as much as conveniently he may, to be distant from the danger of infection of the person dead or of the company that shall bring the corpse to the grave." There were also orders relating to instructions compiled by the College of Physicians for "medicns against the infection," and the College gave certain directions expressly prohibiting the removal, into the country, of any infected person, such removal to involve punishment both on the master of the house from which the infected person was removed, and the master of the house into which he was taken.

Whether Gilbert died in London or in Colchester, it is definite that his half brothers Ambrose and William erected, in the chancel of Holy Trinity Church, Colchester, a monument of marble and alabaster with an inscription in Latin. This has long been pointed out as marking his place of burial, though it is to be noted that the inscription does not state that Gilbert is buried there. The original position of the monument was on the north side of the chancel, and here it stood until Holy Trinity Church was extensively altered and enlarged in 1862, when, but for the precious intervention of the then churchwarden, the late Dr. Henry Laver, Gilbert's memorial would have been destroyed. The stones thus rescued were removed to the position on the north wall of the north chapel, where they have since remained. It may be added that no record of Gilbert's interment has been found (the registers of Holy Trinity Church prior to 1696 have all been destroyed or lost), nor was any search made, in 1862 or subsequently, for a vault or grave in the chancel. Fuller, writing of this very memorial, remarks, with quaintly expressed foresight, that "Mahomet's tomb at Mecha is said strangely to hang up, attracted by some invisible loadstone; but the memory of this doctor will never fall to the ground, which his incomparable book 'De Magnete' will support to eternity." Very modest, in contrast with Fuller's panegyric, is the Latin inscription on the actual monument in Holy Trinity Church, the English translation of which is as follows:—

"Ambrose and William Gilberd have placed this memorial here as a token of brotherly affection to WILLIAM GILBERD their elder brother, Gentleman and Doctor of Medicine. He was the eldest son of Jerome Gilberd Gentleman and was born in the Town of Colchester. He studied the art of medicine at Cambridge and practised it at London for more than 30 years with the greatest distinction and with equal success. Being afterwards summoned to the Court, he was taken into the greatest favour by Queen Elizabeth, to whom as well as to her successor—King James, he acted as Chief Physician. He wrote a book—'De Magnete'—on nautical matters, which had a world wide reputation. He died in the year of human Redemption, 1603 on the last day of November, at the age of 63."

No contemporary portrait of Gilbert has come down to us, though an engraving is extant which appears to have been made from an oil painting formerly to be seen at Oxford. Certain authentic specimens of his handwriting still survive, these including an autograph on a copy of "De Magnete," which Gilbert presented to his friend and colleague, Dr. Lancelot Browne. This particular copy (which is now in the possession of the Society of Arts) contains, moreover, manuscript annotations by Gilbert. Of his books, papers and apparatus, hardly anything is known to exist, the collection bequeathed by him to the College of Physicians having been destroyed in the Great Fire of 1666. One precious object still extant, however, is a globular loadstone, or, as Gilbert called it, "Terrella," which was presented to the Royal Society by Charles II.

The aerial bombardments of the last year have done great damage round about the site of Gilbert's residence in London, and it may be that the street plan hereabout will be obliterated when the time comes to reconstruct the area to the south and south-east of St. Paul's Cathedral. Nothing can obliterate or even dim his fame, and there is no scientific pioneer of comparable brilliance who is commemorated (in stone) more simply. Like Shakespeare, his mighty contemporary, Gilbert had no title of honour such as sovereigns are able to confer, but of him it can be said, as did Ben Jonson of Shakespeare:

"Thou art alive still, while thy book doth live
And we have wits to read and praise to give."

A Trial Run on the Southern Railway

On Sunday last, November 9th, on the invitation of the Southern Railway, we attended a trial run from Waterloo to Exeter, arranged to demonstrate the hauling capabilities of the new "Channel Packet" class of "Pacific" engines recently turned out of the Eastleigh shops to the designs of Mr. O. V. Bulleid, the company's chief mechanical engineer.* The special train, timed to leave Waterloo at 9.50 a.m., was made up of sixteen eight-wheeled coaches, including two Pullmans, amounting to a total weight of no less than 527 tons behind the tender of engine No. 21C3, "Royal Mail." Leaving the terminus a few minutes after the booked time, the new engine very soon showed itself to be master of its job, and by the time Weybridge was reached we were running at 75 m.p.h., the travelling at the time being smooth and comfortable. On the first part of the journey as far as Salisbury the running, while perfectly satisfactory, was somewhat spoiled by delays, thus preventing the locomotive from really showing what it could do. From Salisbury on to Exeter another engine of the same type, "Union Castle," No. 21C2, took charge. Over this section chief interest was quite naturally centred upon the performance on the famous Honiton bank of 1 in 80. Soon after entering upon the climb we suggested to the chief mechanical engineer that we must be doing a "nice 20 miles per hour," and immediately after we "clocked" the train at 25 m.p.h. Other observers on the train confirmed that figure and showed that actually at the top the engine had worked up to about 26½ m.p.h., an excellent performance. This engine, like the other, showed that it, too, could run, and down the other side we touched 79 m.p.h. Owing to the traffic delays experienced on the down journey there was little time at Exeter, as in order to return as nearly as possible at the scheduled time the train started back almost immediately and eventually arrived at Waterloo a little before 7 p.m. From what we were able to see of the working of these new engines, with what must be regarded as an "out-size" in train formations, there is little doubt that they will be able to do well and comfortably what is expected of them in everyday working.

* The Engineer, page 181, March 14th, 1941.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

SELF-PHASING OF THE GARRATT LOCOMOTIVE

Sir,—It is rather difficult to understand why the reciprocating parts of two separate engines, mounted in a single frame, should tend to pull into phase while running, as I gather from Mr. Turnbull's letter is an established fact. One would imagine that if one set of machinery were exerting a greater torque than the other, it would simply mean that the less active set would be relieved of load, but hardly to the extent to cause slipping, unless the discrepancy in torque attained very substantial proportions indeed.

I do not think fair comparison can be made with the old Webb compounds, since in that case a single low-pressure piston could not possibly pull into phase with both the high-pressure pistons, and at best a mean equality of torque might be anticipated, irrespective of any tendency for reciprocating parts to fall into step.

One can imagine that synchronisation of motion between the big low-pressure piston and one of the smaller high-pressure pistons might lead to lack of general balance, and therefore to rough riding, but I knew something of these engines in their day and have always heard that they did, to a great extent, fulfil the object of their design, viz., to combine the free running of the big single-wheelers with the tractive effort of the four-coupled designs. Once in their stride they showed themselves capable of excellent work, as witness their performance in the historic Railway Race to the North on several occasions. Mr. Livesay, some months back, drew attention to their strange antics when starting a heavy train, and it was no unusual spectacle to see the rear drivers spinning furiously ahead while the leading pair kicked spasmodically astern, due to their slip excentric gear stopping in the wrong position, a combination of circumstances calling for a friendly "bunt" from the nearest yard "shunter" available, which detracted considerably from their dignity.

Mr. Stanier's paper explains for the first time the true reasons for the success of the French compounds, and the comparative failure of compounding in this country, but if the

economy of two expansions is worth pursuit might it not be attained by employing a high-speed engine with two or even three expansions, in combination with geared transmission, which is now so well proved in many types of main line locomotives of the diesel, electric, and turbine types, thus escaping large-diameter cylinders and the loading gauge limitations ?

S. P. CHRISTIE.

Southsea, November 10th.

THE KIEV SUSPENSION BRIDGE

SIR,—It may be of interest to many who saw in *The Times* of the 5th inst. an illustration showing German engineers building a pontoon bridge " in place of one destroyed . . . in the neighbourhood of Kiev," to know that the damaged structure was a fine suspension bridge built about 1848–53 by the English railway engineer Charles Blacker Vignoles, by command and under the direction of the reigning Emperor of All the Russias.

Extracts from Vignoles' diary, quoted in his Life published in 1889, give vivid details of the almost insurmountable difficulties encountered during the erection of this bridge, disastrous ice floods sweeping away or destroying all the first foundations in 1848 and 1849. However, after endless and vexatious delays, due to problems of labour, transport, and epidemics of cholera, the foundation troubles were finally overcome by the use of " fascine mattresses " sunk round the cofferdams, a method much criticised by the Russian experts at the time, but which proved entirely successful, for the diary records that the floods of 1849–50 " fortunately did no harm."

The completed bridge was not actually opened till 1853, by the Emperor's son, the Grand Duke Nicholas, the Emperor, to Vignoles' great disappointment, " having no time," though he had often visited the work and shown great interest in the progress of the arduous undertaking. In 1889 the author of the Life remarks that the bridge " still withstands the shock of the ice floods that sweep down upon its piers, and though ' built upon the sand ' has not yielded one inch."

Two fine models of the bridge were made. One was presented to the Emperor of Russia (Nicholas I) and the other was exhibited at the Crystal Palace in 1854, where it was destroyed by the great fire of 1866. The cost of the two models was more than £7000.

THE ENGINEER'S GRAND-DAUGHTER.

November 10th.

FACTS ABOUT THE RIFLE

SIR,—All who are interested in firearms owe a debt of gratitude to Mr. D. Weir for his interesting article, " Facts About the Rifle," and to Mr. Ian Glendenning for his letter, which you published in your issue of Sept. 5th, 1941.

It is almost axiomatic that experts should disagree, but there are few points of difference between Mr. Weir and Mr. Glendenning. I am wondering, though, whether the latter is correct when he says that rifled pistols disappeared after Prince Rupert's time. He gives no date for their reappearance, but Mr. George, in his interesting book, " English Pistols and Revolvers," gives illustrations of the following weapons :—

(*a*) Rifled screw-barrelled holster pistol, by Ed. Nicholson, *circa* 1650.

(*b*) Rifled pistol, by Hudson, *circa* 1720.

(*c*) Pair of rifled pocket pistols, by Ketland and Co., *circa* 1750.

(*d*) Rifled pistol of target or duelling type, by W. Moore, 1820.

These illustrations seem to establish the continuity of the rifled pistol, although admittedly smooth-bored weapons were much more common. Probably the reason for this lies in the fact that a screw-barrelled pistol takes longer to reload than a smooth-bored, muzzle-loading weapon.

It seems probable that Mr. Glendenning is on the right track when he suggests that rifling was first tried as a solution to the problem of fouling, which was considerable with the crude propellants in use in the early days of firearms. Otherwise, how does one account for the straight-grooved, rifled arquebus ? Perhaps the idea was tried and subsequently abandoned as a failure. Can any reader suggest any other reason ?

Is Mr. Glendenning correct when he says : " Every English bowman knew that it was necessary to turn the shaft of the arrow rapidly in the air, if it was to fly true . . ." ? I know little about archery, but all the arrows that I have seen definitely did not turn in the air. On the other hand, I believe that the crossbow quarrel does spin in flight.

W. G. BROWN.

Pettaugh, November 10th.

The Beginnings of the Newcomen Society*

By ARTHUR TITLEY, M.I. Mech. E., F.R.S.A.

APPROPRIATELY enough, it was at Heathfield Hall, built by James Watt in 1790, and his residence for the rest of his life, that the first idea of forming our Society arose. On the first day of the Watt Centenary Commemoration meeting in Birmingham, September 16th, 1919, I was taking tea in the tent at Heathfield with my old friend, the late John W. Hall, afterwards one of our Presidents, when I suggested to him that we should form a society for the study of engineering history. He laughingly said, " Well, you are the first to suggest that," visualising, I suppose, a party of elderly engineers groping over the scrap heap, searching for relics of their pre-apprenticeship days. He added, " But if you will start it, I will become a member."

It was on the next day, September 17th, that a party of those who attended the Commemoration rode out to Ocker Hill in a motor char-a-banc to see the old Watt engine of 1777, belonging to the Birmingham Canal Navigations, working under its own steam. There was a fair-sized party in the coach, most of whom were unknown to me. Among them was our late member, Mr. Alfred G. Scholes, an old Soho man, as his father was before him, who kept up a running commentary on the doings of Soho Foundry and its personnel. Among the company I noticed one who, alert and keen, was evidently making critical mental notes on what Mr. Scholes was saying. I think I need hardly say who that person was.

When we alighted at the gates of the pumping station at Ocker Hill, I spoke to Mr. Dickinson (for the first time) and made the suggestion to him. He at once agreed, and said, " We will find you in London half a dozen members," meaning the staffs of the Science Museum and of the Patent Office. " But the man you want to know is Mr. Rhys Jenkins," to whom he then introduced me. Shortly after this, being in London, I called upon Mr. L. St. L. Pendred, and on Dr. T. E. Lones (at that time an examiner in the Patent Office). Both welcomed the idea.

The matter was followed up in London by Mr. Jenkins and Mr. Dickinson, and in Birmingham by myself. On May 5th, 1920, we held a meeting at my office in Queen's College Chambers, Paradise Street, at which seven prospective members were present. We formed a provisional Birmingham Committee, consisting of W. H. Dugard, J. W. Hall, H. C. James-Carrington, and myself, and reported what we were doing to Mr. Dickinson. We arranged that he should take similar measures in London till we could meet there. Accordingly, the meeting took place in London on June 4th, 1920, being held by the kindness of Mr. Pendred at the offices of THE ENGINEER, at that time at 33, Norfolk Street, Strand. It was at this meeting that the Society may be said to have taken concrete form. Fourteen prospective members were present. I reported what we had done in Birmingham, and a general discussion took place as to the conduct of the Society. On the proposal of Mr. Jenkins, I was asked to act as President, and a London Committee was elected, consisting of Messrs. Dickinson, Jenkins, Hulme, and Pendred, with the first named as hon. secretary, to collaborate with the provisional Committee already formed in Birmingham. Further discussion took place on that very important point as to what should be the name of the Society, and various suggestions were made. It was felt that some name, brief, with an implied historical appropriateness, was needed. No solution was reached, and the meeting left this important point to be settled by the Committee.

The next step, and a very memorable one, was an invitation from Mr. Pendred to the Committee to dine with him that evening at the Savage Club. There in that wonderful home of the Club in the Adelphi overlooking " the River of Thames," a very pleasant party found inspiration. The name to be borne by the Society was discussed at length. To name the Society after some eminent engineer of old, such as Watt, seemed at first very natural, but we thought that this might not be entirely free from notes of discord inherited from the past. It was to Mr. Pendred and Mr. Dickinson that inspiration finally came, and we all agreed to adopt the historical name of Thomas Newcomen, of Dartmouth, Devon, the man who first drove a piston through the agency of steam. Happily, all the persons who were at this historic and pleasant dinner are still active members of the Society.

The Society had a hearty send-off in a leading article in the columns of THE ENGINEER.† I venture to quote from it because our aims were so well expressed, and the hope held out has been so largely realised :—

> " We hope to see the new body carrying on for many years a work which has not only the peculiar and indefinable attraction that pertains to archæology, but has an educational and refining influence which cannot be precisely measured, but which we may justly claim is not less observable in the history of engineering and technology than in political, military, and social history. All men are better for doing honour to the great dead ; all engineers, all technologists are the better for studying the works of their illustrious predecessors. Just as military captains still examine the battles of Marlborough, Wellington, and Nelson for knowledge and inspiration, so may we in the industrial world look back for encouragement and enlightenment to the scores upon scores of thinkers, inventors, and workers who painfully carved the first rough steps up which we have climbed to greater things."

Our first ordinary general meeting, and it is this that we now commemorate, was held on Friday, November 5th, 1920, in the Court Room of H.M. Patent Office, Southampton Buildings, W.C.1, by kind permission of the Comptroller. The paper was given by Mr. E. Wyndham Hulme at the express invitation of the Committee, and its subject-matter was appropriately " Introduction to the Study of Historical Engineering to the Year 1640." It was accompanied by an exhibition of rare books from the Patent Office Library. The election of twenty-five members was announced, and at the next Committee meeting on January 27th, 1921, twenty-seven more members were elected.

The first of many pleasant Summer Meetings was held in Birmingham on June 16th and 17th, 1921. The first annual general meeting was held on December 15th, 1921. The Society had now set forth on its career. Looking back through these twenty-one years, and browsing through our " Transactions," issued during this period, I feel that the Society has established for itself a position of which we may well be proud, and which ensures the continuance of its progress.

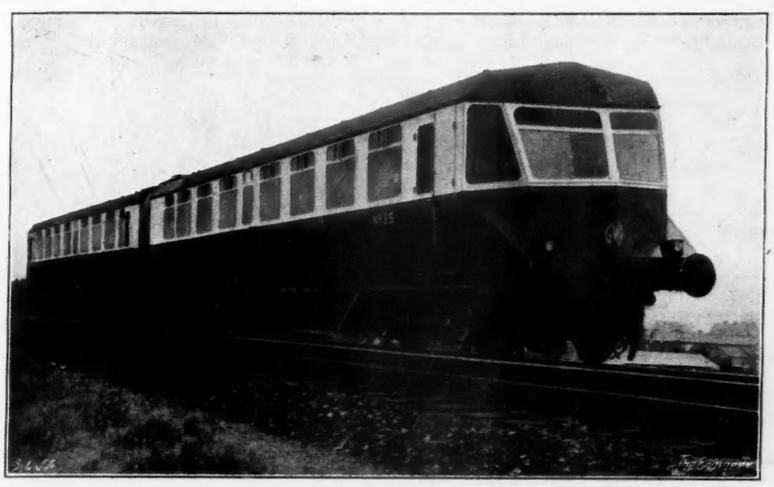
It is a great satisfaction to me to have seen the friendly spirit that has throughout marked its development. Its good fellowship has marked its history and many abiding friendships have been made between us.

* An address read by the first President of the Society at a meeting held on November 12th to celebrate the attainment of the Society's majority.

† THE ENGINEER, Vol. 129, page 605.

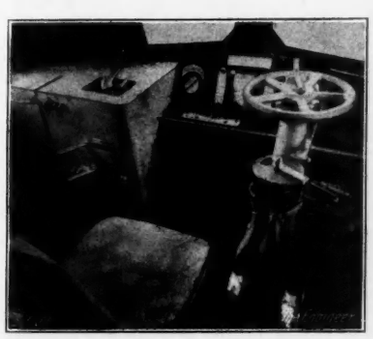
Twin-Coupled Railcars for G.W.R.

SOME time ago an order was placed by the Great Western Railway with the Associated Equipment Company, Ltd., of Southall, for twenty oil engine-driven railcars to supplement the eighteen cars already running before the war on its system. The first of those twenty cars was completed in April, 1940, and was fully described and illustrated in our issue of May 17th and 24th of that year. That car was a single unit and it was fitted experimentally with a dual-range gear-box, making it suitable either for operation by itself at a maximum speed of 65 m.p.h. or with a trailer at a maximum of 40 m.p.h. One of the cars in this order, intended for the carriage of parcels, has also been described in our pages.



TWIN-COUPLED RAILCARS

We are now informed by the Associated Equipment Company, Ltd., that the first of two twin-coupled railcars included in the order has just been delivered. These units, one of each pair of which is fitted as a buffet car, are so designed that a standard corridor coach can be coupled between them. Twin coupled, the tare weight is 72 tons and they can carry 104 passengers, whilst with the corridor coach the tare weight is 108 tons and the capacity is increased to 184 passengers. In the latter case the loaded weight with passengers and luggage is about 120 tons.



DRIVER'S CONTROLS

The general design of each of the railcars is much the same as that of the single cars described in the article mentioned above. Power for each car in the twin is provided by two six-cylinder engines, 120 mm. bore by 142 mm. stroke, developing 105 B.H.P. at 1650 r.p.m. and the arrangement of the engines and drive is as described in earlier articles. The cars are carried by bogies set at 43ft. 6in. centres, the bogie wheel base being 8ft. 6in. Five-speed gear-boxes provide speeds of 12, 17, 30, 46 and 75 m.p.h., and the maximum tractive efforts in bottom and top gear are 11,380 lb. and 1840 lb. respectively. An accompanying engraving shows the control table and other pictures illustrate the interior and exterior appearance of the railcar.

A test run of the twin railcars with a standard corridor coach coupled between them was made on October 15th from Southall to Westbury and back, a total distance of 172½ miles. The tare weight of the complete unit was 108 tons and with passengers was approximately 110 tons. The addition of the trailing coach reduced the horsepower per ton by approximately 30 per cent. and had some effect on the speeds obtained, especially when accelerating or on gradients. Nevertheless, on the return journey speeds of 70½ m.p.h. were officially observed at Bedwyn and Newbury. In both runs the cars proved to be smooth riding, even at 70 m.p.h.

On the outward trip stops were made at Reading, Newbury, Bedwyn and Patney; but on the return run, planned as non-stop, adverse signals brought the unit to a standstill for three minutes at Reading. Thereafter speed was affected by the presence of an express ahead, although the 27 miles to Southall were accomplished without stop. From Southall to Newbury the line is practically level. It then rises gently to Bedwyn, where the gradients become steeper to Savernake summit. Descending gradients follow to Pewsey, after which the line is undulating to Patney. Thence it drops fairly steeply to Lavington.

The following speeds were obtained :—

Outward

	Miles		
Southall–Reading	27	at 43½ m.p.h.	Two checks
Reading–Newbury	17	at 45 ,,	One check
Newbury–Bedwyn	13½	at 42½ ,,	
Bedwyn–Patney ...	14½	at 44½ ,,	
Patney–Westbury	14½	at 27 ,,	Stopped outside Westbury for 12½ min.

Return

	Miles.		
Westbury–Reading	59½	at 54 m.p.h.	Two checks
Reading–Southall	27	at 46½ ,,	Four checks

Average speed for both trips, 173 miles at 45 m.p.h.

On the return trip passing times were :—

	Miles.	
Westbury start to Patney pass	14½	at 45 m.p.h.
Patney pass to Bedwyn pass	14½	at 56 ,,
Bedwyn pass to Newbury pass	13½	at 65 ,,
Patney pass to Newbury pass	28	at 60 ,,
Newbury pass to Reading stop	17	at 32 ,, (checked)

Fuel consumption for the day was 49 gallons, which equalled 3·6 miles per gallon, or 396 ton-miles per gallon.

The latest twin-car sets have been designed primarily for working over the 117-mile route between Birmingham, Gloucester, Newport and Cardiff, a route upon which A.E.C. twin-engined cars provided with buffets and lavatories were first placed in 1934. By completing the journey in one direction in 2 h. 19 min. and in the other in 2 h. 30 min. (including stops) they gave not only a direct, but also a faster service than had previously been available by steam stopping train. The outcome was a steady increase in traffic, which in time became so large that the 44-seater railcars had eventually to be replaced by steam trains. It is for this reason that the twin-coupled cars are now to be used, and the experiment tried of utilising also a standard compartment corridor coach to make up a three-unit set with a total seating accommodation of 184.

INTERIOR OF BUFFET CAR

Recent Motor Cargo Ship

IN an article published in our issue of September 26th last, we were able to give some drawings and engravings of one of a series of standard cargo ships designed and built by Joseph Thompson and Sons, Ltd., of Sunderland, for the Ministry of War Transport. These ships are steamships propelled by North-Eastern three-cylinder triple-expansion engines taking steam from two Scotch boilers.

The ship we are permitted to describe and illustrate in the present article was constructed by the Burntisland Shipbuilding Company, Ltd., and is propelled by a three-cylinder two-stroke Doxford opposed-piston oil engine. The design is modern in every way, which should ensure this particular type of vessel a place in the post-war ship construction programme. It is built for the economical carriage of coal, grain, and general cargo, and the principal particulars are as follows :—

Hull Particulars

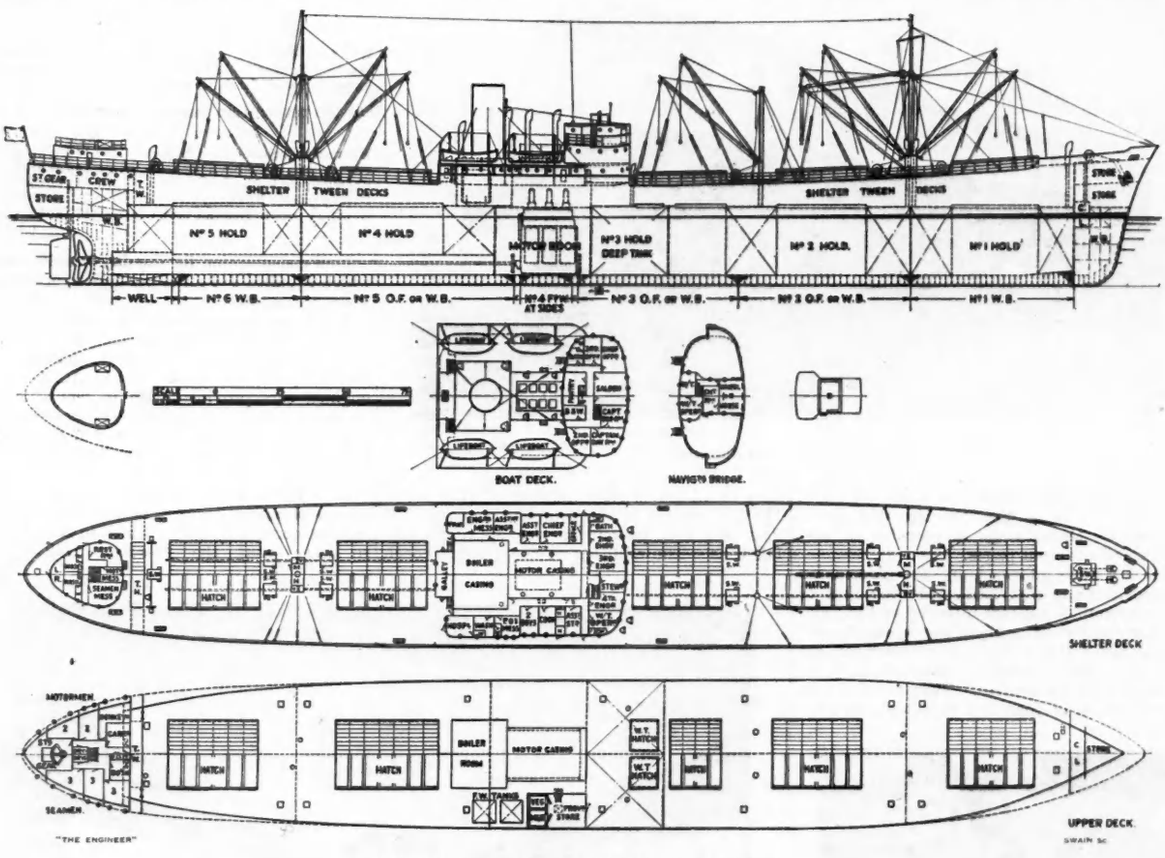
Length between perpendiculars	425ft.
Breadth moulded	57ft.
Depth moulded to shelter deck	37ft. 9in.
Deadweight carrying capacity—	
Closed shelter deck on 27ft. 4in. draught	10,200 tons
Open shelter deck on 25ft. 10in. draught	9,400 tons
Gross tonnage—	
Closed shelter deck	7,000 tons
Open shelter deck	4,870 tons
Net tonnage—	
Closed shelter deck	5,170 tons
Open shelter deck	2,840 tons
Grain carrying capacity, with closed shelter deck	578,000 cubic feet
Designed speed	12 knots

As will be seen from the accompanying profile and plan drawings, the ship is of the single-screw type, and is built to a model which, we are informed, embodies the most up-to-date features of propulsion technique. Particularly noticeable is the comparatively small fore and aft length of the engine-room, which houses a three-cylinder Doxford engine working on the opposed-piston two-stroke principle, with airless injection of the fuel. The unit has a designed output of 2500 S.H.P. when running at 108 r.p.m., corresponding to a sea speed, in fully loaded condition, of 12 knots. The pistons have a diameter of 600 mm., with a combined stroke of 2320 mm. Steam is employed throughout for auxiliary purposes, and it is raised in two cylindrical oil-fired boilers, one of which is normally in operation when at sea, and utilises the exhaust gases from the main engine. This boiler is built to generate sufficient steam for the operation of the ship's principal auxiliary machinery during a sea voyage.

From the drawings we give it will be seen that the steam boilers do not take up valuable tank top space in the engine-room, but are conveniently arranged in the 'tween deck spaces, thus setting free increased cargo hold space. The funnel is placed towards the after end of the machinery space, and takes the exhaust from the two boilers, in addition to that from the main engines.

The general design of this new type of motor vessel is of interest, not only on account of its high cubic capacity, but because of the neat way in which the principle of streamlining has been applied to the superstructures of the ship. The builders have combined all the accommodation for the navigating officers and the engineers in one centrally arranged island, the cabins being arranged at the sides and at the forward end. The general idea underlying this particular arrangement of the main superstructure is to minimise any resistance, taking into account all directions of wind pressure, while at the same time reducing to a minimum any disturbance with the lay-out of accommodation to meet all essential conveniences. The solution which has been adopted is, we believe, somewhat new in British cargo ship practice, and one on which the builders are to be congratulated.

In conclusion, we may state that the arrangements for the loading and discharging of the ship are in full accordance with the latest practice, while the sharply raked stem and the deep cruiser stern give the vessel a pleasing outline.



PROFILE AND PLAN OF MOTOR CARGO SHIP

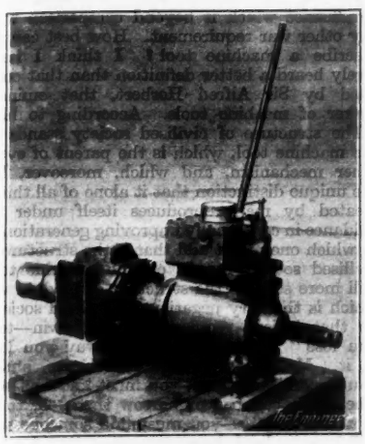
Hydraulic Press for Mounting and Removing Axle-boxes

A PORTABLE hydraulic press for mounting and withdrawing axle-boxes, either by hand or electric power operation, has been designed by British Timken, Ltd. It is not intended to replace or compete with the ordinary wheel press to be found in most large shops, but efficiently to press an axle-box on to, or withdraw it from, the axle. Being portable, the press is particularly useful in emergency and when wheel sets cannot be moved conveniently to outlying depôts. Timken axle-box bearings are always given press fits on to the axle. This is standard practice, and is claimed to have many advantages over such methods as the use of taper sleeves, locking nuts and other devices. It has been felt, however, that this method has been open to the objection that the axle-boxes cannot be pressed on to or withdrawn from the axle without making use of a wheel press. This objection has now been overcome by the advent of the Timken concentric hydraulic press.

One important object in evolving the design was to provide a powerful tool capable of exerting a pressure of 75 tons, but light enough to be really portable. The outstanding feature which has made it possible to build such a tool is the construction of the jack, the part of the press through which the pressure is exerted. A ram with a centre bore enables an extension bar, which is secured to the end of the axle either by screwing on direct or by a screwed insert ring which slips into a groove in the axle end, to pass through. This serves a double

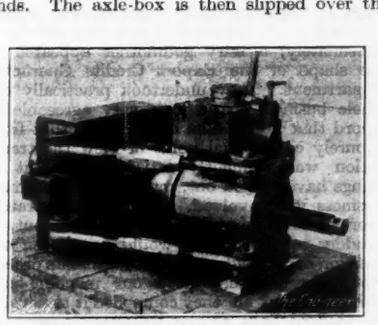
purpose. First, it acts as a support during assembly of the press, and secondly, it serves as a tension bar which provides the resistance necessary when pushing on bearings against a press fit.

The combined pump and jack unit, which constitutes the hand-operated press, is provided with a straight-through lifting hole, through which a lifting bar can be passed. It can then be easily carried by two men. Lifting lugs are provided on the power-operated jack for the same purpose. With either the hand or power-operated press an axle-box can, we are informed, be mounted or removed in ten minutes, including the time taken to set up the equipment and



PRESSING AXLE-BOX ON TO AXLE

prepare the axle-box. The jack is carried on the extension bar referred to above and is secured to a pilot slightly smaller in outside diameter than the bore of the bearing. The pilot is secured to the axle by one or other of the following means :—(*a*) By machining a groove in the axle end so that a threaded split insert ring can be employed, thus providing the thread for the pilot ; this method is now standard Timken practice and is said in no way to interfere with the strength of the axle or the employment of the slip-on type of pilot sometimes used ; (*b*) by screwing the pilot direct on to the axle, many axles being provided with screwed ends. The axle-box is then slipped over the



WITHDRAWING AXLE-BOX FROM AXLE

extension bar on to the pilot, and a pressing-on sleeve and thrust disc are placed in position. Finally, the press unit and a retaining nut are attached. Pressure on the ram is built up by operating the handle of the hand-operated unit or by means of the electrically driven pump of the power-operated press, and is indicated in tons on a pressure gauge.

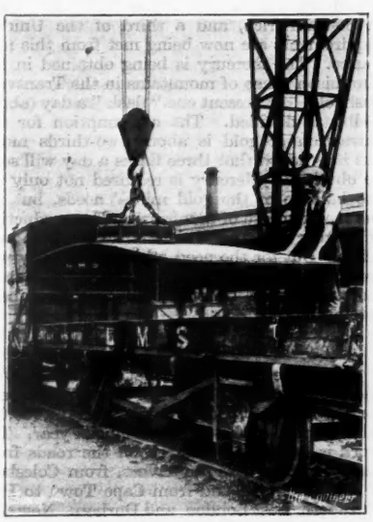
To withdraw an axle-box use is made of a two-piece withdrawal box, the halves of which are placed over the axle at the rear of the axle-box and bolted together. The withdrawal box is attached to the press by four tie bars equipped with screw adjustment for length. The press, supported as before by the extension bar, is attached to the axle end by one of the methods already described. A tubular piece—in place of the pressing-on sleeve—and a thrust disc are placed between the screwed-on pilot and the ram, but the retaining nut is omitted. As in this case it is impossible for the ram to move forward relatively to the axle, the cylinder moves backward carrying the withdrawal box and axle-box with it.

In the power-operated unit the pump is connected to the jack by a flexible copper pipe. In the event of power failure it is possible by the use of a handle to employ the power unit for hand operation. A device is fitted to prevent the handle being attached while power is available, and conversely, the current cannot be switched on while the handle is in position. The pump unit, like the hydraulic jack, can be easily carried by two men and is mounted on a hollow wooden base which has one side hinged so as to provide a useful locker for tools.

The press, it is claimed, is a very handy workshop tool, as it can be used for many jobs other than the pressing-on and withdrawal of axle-boxes.

40-Ton Electro-Magnet on the L.M.S. Railway

With a view to speeding up the discharge of railway wagons conveying important consignments of iron and steel, an electro-magnet has recently been fitted to a 40-ton electrically operated Goliath crane on the L.M.S. Railway, and we illustrate the equipment in use. The magnet is 38in. in diameter, constructed of high permeability steel, and is designed for general use. The weight which it will lift varies



ELECTRO-MAGNET IN USE

from 7 cwt. to 7 tons, depending on the size, shape, and class of the ferrous metal to be lifted. It is controlled by a hand-operated potentiometer controller and is energised at 220 volts D.C. from an A.C./D.C. motor generator set mounted on the crane. The power consumption of the magnet and control gear is 4¼ kW. The magnet coil is fully impregnated against ingress of moisture, and is suitable for outdoor use in all weather conditions. The flexible cable to the magnet is provided with an earth wire as a safeguard against possibility of shock to those handling the magnet. The use of such equipment is an example of methods by which the more rapid turn-round of railway wagons can be effected.

Bequest from an Employee.—For the first time in its existence the General Electric Company of America has become the beneficiary under the will of a retired employee. John E. Popper, an engineer who was in the employ of the company thirty years ago, has left 1000 dollars to the company to assist one or more students in the training courses. Mr. Popper was general manager of the Mukden (Manchuria) Electric Light Works when he retired in 1934.

Sixty Years Ago

The Forth Bridge

In our issue of November 11th, 1881, we reported that the scheme for the construction of a bridge across the River Forth was progressing favourably. The railway companies concerned in it, namely, the North British, North-Eastern, Midland and Great Northern companies, had applied to Parliament for powers to construct a steel girder bridge in place of the suspension bridge which the late Sir Thomas Bouch had designed and which had been abandoned after the fall of that designer's Tay Bridge. The main outlines of the proposed girder bridge had already been determined by Messrs. Fowler and Baker. We described it as a continuous girder bridge of varying depth and said that it would have two spans, each of about 1700ft., and two of about 600ft. Over the piers the girder would have a depth of 330ft., while the depth at the centre—or of the suspended spans, as we would now call them—would be 55ft. The width across the lower booms of the trusses would taper from about 112ft. at the piers to 30ft. at the centre and across the upper booms from 50ft. at the piers to the same 30ft. at the centre. The lower or compression ribs of the trusses would be circular in section. Following the disaster to the Tay Bridge, the designers and the Board of Trade had fixed the wind pressure to be allowed for at the entirely impossible figure of 112 lb. per square foot, as compared with the 10 lb. assumed for the Tay Bridge. In addition, the maximum working stress was taken at 6½ tons, as against the 10 tons allowed for in Bouch's design. It was intended, we understood, to fix the sectional areas of the girder members by direct experiment on models and not to deduce them from indirect experiments on the steel itself. In Bouch's suspension design a rolling load of 600 tons on each line was allowed for. In the new design the rolling load was taken at 1700 tons. . . . This early description of the Forth Bridge design fits the bridge as actually constructed with close agreement. Rather curiously we did not mention the word "cantilever" throughout the whole of our article, although from what we said regarding the method to be employed for erecting the bridge it seems evident that we were aware that the cantilever principle was to be employed. Our description of the structure as a "continuous girder bridge" is substantially accurate, for as constructed the bridge is in effect a continuous girder from shore to shore.

South African Engineering Notes

(*By our South African Correspondent*)

Cape Town, September.

Cape Town Electricity Undertaking

Under a pooling agreement the electricity requirements of the Electricity Supply Commission's Cape Town undertaking and the Cape Town Corporation are now largely generated at the Corporation's Table Bay power station, which came into operation in 1939 and has since superseded the Commission's Salt River power station as the base-load station. The old Dock Road power station owned by the Council is being retained as an emergency station. The total units sent out from the pooled stations in 1940 amounted to 413,937,772. Of this quantity, Salt River power station sent out 57,580,150 units, compared with 129,224,222 units in 1939 and 333,587,582 in 1938. In consequence of the reduced output, the thermal efficiency of Salt River power station fell from 20·3 per cent. in 1938 to 17·7 per cent. in 1939, and to 14·1 per cent. in 1940. The maximum half-hourly demand sent out was 46,200 kW, and the load factor was 14·3 per cent., calculated on 8736 hours. Sales of electricity to consumers of the Cape Town undertaking increased by 12·51 per cent. to 119,770,941 units in 1940. The average price per unit sold to all consumers

of this undertaking was reduced from 0·789d. in 1939 to 0·752d. in 1940. Sales for traction purposes averaged 0·682d. per unit, being 0·033d. per unit lower than the average for 1939. Revenue for the year was £380,840, and working costs amounted to £384,369, which includes £200,833 in respect of the Commission's proportion of the pooled costs of the Salt River, Table Bay, and Dock Road power stations.

An agreement was concluded during the year with the Worcester Municipality for a partial supply of electricity from the Cape Town undertaking to supplement the output from the Council's own generating station. To provide this supply, a 33-kV transmission line has been constructed from a point near Wellington as an extension of the present system. This line will cross the mountains and will also make electricity available in the fertile Hex River Valley. The Caledon power station, which, together with the local distribution system was purchased by the Commission from the municipality in 1939, generated 371,408 units of electricity in 1940 for supply to 449 local consumers, whose consumption shows an increase of 6·45 per cent. over 1939.

Vaal Generating Station Undertaking

Reports from overseas indicate that the manufacture of the generating plant for the Vaal power station is proceeding satisfactorily. Construction of the circulating water system, including the two hyperbolic cooling towers each 320ft. high, coaling appliances, railway sidings, and staff quarters have been completed, and erection of the steel-frame generator house is nearly completed. Additional land, approximately 168 acres in extent, adjacent to the existing power station site, was acquired during the past year to provide for more ash dumps and the incoming power line network.

Vital Research Work

The tenth annual report of the South African Fuel Research Board says that the Board has authorised the investigation of special problems submitted by the Royal Air Force, the South African Air Force, other sections of the Union Defence Force, and industrial and agricultural organisations. Both the Institute of Fuel Research and the Geological Survey have agreed to curtail the coalfield survey to work that is of national importance, and to investigations in which undue delay would result in loss of valuable data. Their collaboration is largely concentrated on a survey of torbanite resources, a survey of coking coal reserves, and an investigation into the nature and origin of certain "pseudo-coal" veins in the Karoo, which were expected to have a bearing on the question of oil possibilities in that area. The Institute's investigations into the regeneration of used lubricating oil included tests on the performances of various commercial machines and the designing of a new type of plant, which has been found to give extremely satisfactory results. The cost of construction was low, and the capacity and performance high. The Institute has also found an excellent substitute for imported earths in oil regeneration.

New Motor Vehicles in the Union

New motor-cars to the number of 2040 were registered in the Union during July. Of these, 1943 came from America, 89 from the United Kingdom, and 8 from other countries. During the same period 739 new motor buses, lorries, trucks, and vans were registered in the Union. Only six new motor cycles were registered.

Work for Men After the War

Important developments to make possible the construction of locomotives and rolling stock in the Union have been announced by the Minister of Railways and Harbours, Mr. F. C. Sturrock, in a recent speech at Benone. Mr. Sturrock said a reserve of £7,000,000 was being built up to meet the post-war rehabilitation of men now serving in the Forces. It was his firm intention that there should be no increase in railway rates after the war, no retrenchments, and no cuts in wages. Work must and would be found for all soldiers needing it. In preparation for peace, big financial reserves were being built up. "I am building up the rates equalisation fund to £7,000,000—it now stands at £5,000,000—and I have every hope that I shall achieve my ambition before the war ends," said Mr. Sturrock. Great capital works were being held up, but the day was not far distant when South Africa would make her own locomotives, trucks, carriages, and all other accessories. In other ways also the Government is looking ahead to the time when there will be large numbers of men for whom work must be found.

Ship Repairs in Union

Control of all merchant shipping repairs in the Union ports is to pass to the South African Railways Administration, according to a decision which has been taken by Mr. C. M. Hoffe, general manager of railways. There will be one controller at each of the three chief ports —Cape Town, Durban, and Port Elizabeth. At Durban Mr. W. H. Waudoy, formerly mechanical engineer at Pretoria, will be controller of repairs. The present directorship of merchant ship repairs is replaced by the controller. Mr. Hoffe has recently been conferring with official and municipal authorities regarding the site and lay-out of Durban's new railway station.

Mercury in the Union

Mercury for the gold-mining industry was obtained before the war from the shores of the Mediterranean, but it has now been found in South Africa, and a third of the Union's requirements are now being met from this new source. The mercury is being obtained in the Murchison range of mountains in the Transvaal bushveld. At present one "flask" a day (about 75 lb.) is distilled. The consumption for the extraction of gold is about two-thirds more, but it is hoped that three flasks a day will soon be obtained. Mercury is required not only for the balance of the gold mines' needs, but for the manufacture of munitions. The production of mercury in the Union is definitely a war effort. But for the need brought about by war conditions it is unlikely that the distillation of mercury in the Union would ever have been attempted.

Union National Roads

The war is somewhat interferring with the progress of the National Road programme for the Union of South Africa, but £3,000,000 will be spent in the current financial year. The work is being concentrated on the roads from Cape Town to Beaufort West, from Colesberg to Bloemfontein, and from Cape Town to Port Elizabeth, East London, and Durban. New construction work on some other roads has been stopped, but what has already been done will be maintained to gravel standard. Bridge construction will continue, provided it is possible to secure the materials. Steel is the main obstacle, but the Road Board has enough to build certain bridges. The work of building strategic roads which was undertaken on the outbreak of war has not yet been completed. By special request, the Board has released about 2000 men and about £100,000 worth of machinery to assist in the campaign of the Union forces in East Africa. The work of these units has been highly praised by General Smuts, General Wavell, and General Cunningham.

Port Elizabeth's Water Problem

The City Council of Port Elizabeth has been vainly searching in every direction for pipes to complete the 29-mile gap in the supply line from the new Kromme River reservoir. This is the result of the British Government imposing a ban upon the export of iron or steel pipes from Britain, so that the completion of the work is held up after about £750,000, or half the amount required for the scheme, has been expended. The Council is now falling back on an arrangement which has been made with the Uitenhage Town Council for a temporary supply from that town's water supply. It has been agreed by the Port Elizabeth Council to ascertain whether pipes can be obtained from the Pretoria steel works to build a pipe line to Port Elizabeth from the Uitenhage municipal reservoir, to supply the city with a million gallons daily. If this cannot be arranged, it will be necessary to pull up and utilise some of the pipes already installed in the uncompleted line from the Kromme River.

Machine Tools and the War*

In this war machine tools have attained a significance which is beyond comparison with any other war requirement. How best can we describe a machine tool? I think I have rarely heard a better definition than that compiled by Sir Alfred Herbert, that eminent maker of machine tools. According to him, "The structure of civilised society stands on the machine tool, which is the parent of every other mechanism, and which, moreover, has the unique distinction that it alone of all things created by man reproduces itself under his guidance in continually improving generations," to which one might add that if the structure of civilised society stands on the machine tool, still more so does the structure of modern war which is the very negation of civilised society. So that it is a regular "Heads I win—tails you lose" business, whichever way you look at it. Machine tools you must have, and if you haven't got them, you must know at least where you can beg or borrow them—or to be more up-to-date—you must find someone who will lease or lend them.

Incidentally, while on the subject of machine tools, may I digress for a moment to remind you of the part the Russians have played in the earlier stages of the battle of the machine tools. Let me take you back ten years or so.

In the period 1929–31 our engineering industry as a whole, and our machine tool industry in particular, was passing through a most difficult time. It is no exaggeration to say that several firms were on the verge of closing down. It was at this stage that our machine tool industry was saved by one country and one country alone. Seventy per cent. of the value of our machine tool exports went to the Soviet Union. And, roughly speaking, the orders placed at that time and in the following years amounted to no less than ten million pounds. Manufacturers wanted the orders, but they were frightened of the risks involved. Fortunately, a fairy godmother appeared in the shape of the Export Credits Guarantee Department. They undertook practically the whole business. And it is very agreeable to record that no defaults occurred, so that from a purely commercial point of view the transaction was eminently satisfactory. But as things have turned out, much more than mere business was involved. We were desperately short of machine tools when war broke out. I shudder to think what would have been our position had it not been for those Russian orders. Not only did they keep our machine tool industry going, but they compelled it to develop on modern lines as the Russians insisted on having the best and most up-to-date machines.

How rarely it is that one can look back after many years and reflect that from whatever angle you consider it, a transaction has proved completely satisfactory.

Connectors for Timber Bridges.—A recent issue of our Canadian contemporary, *Roads and Bridges*, contained an informative article on the use of iron connectors in the construction of timber bridges. Some ten types of rings, shear plates, spike grids and clamps are used with bolts of appropriate length. Typical examples of this method of construction were illustrated, the most notable being the Sioux Narrows bridge on King's Highway, 50 miles south of Kenora, Ont., a timber truss structure of 210ft. clear span.

* From the Inaugural Address entitled "Co-operation for Production" delivered by Sir Edward Crowe, Chairman of Council, to the Society of Arts.—Nov. 5th.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

Wrought Light Alloys

The Wrought Light Alloys Development Association, formed to promote the increased application of the strong aluminium alloys, has adopted as its main policy at present the dissemination of all the available information on the physical, mechanical and working properties of these materials in order to assist the war effort to the fullest possible extent. The light alloys have steadily progressed during the past twenty-five or thirty years and to-day they constitute one of the most essential sections of the war industries, while expansion is still continuing. Difficulties encountered in the manipulation, heat treatment and finishing of some of these alloys, particularly in works where they have not previously been employed, are usually due to lack of experience, or scarcity of information on the technique required. Further, there is a shortage of personnel trained to deal with light alloys and at present it is not always possible for material suppliers to give their customers the detailed attention they would desire. The Association therefore intends to place its services at the disposal of any fabricators or users of aluminium alloys having problems which cannot be solved in their own works. The Association was actually incorporated as a company (limited by guarantee) early this year, and it comprises the principal makers of the wrought light alloys in this country. Dr. E. G. West, who has had a varied experience of the light alloys, has recently taken up the post of manager with an office at 34, New Street, West Bromwich. When peaceful pursuits can again be followed the W.L.A.D.A. will continue its advisory service.

Licensing of Exports

Under a Board of Trade Order of November 4th, 1941, export control is extended to cover a wide range of metal manufactures. The full details of this Order (S.R. & O., 1941, No. 1713) are as follows: Licences will, in future, be required to export the following classes of goods to all destinations:—Steel shot, grit and sand; steel rules and measuring tapes; bells, bell domes and bell gongs; metal ladders; stationery, wholly or mainly of metal; cash registers; duplicating machines; welding electrodes; metal wheelbarrows; parts and accessories, wholly or mainly of metal, of perambulators, mail carts, invalid carriages, rail locomotives and rail vehicles; points, switches and crossings, chairs, tie bars, and rail brakes; wheels, tyres, hubs, axles and brakes, wholly or mainly of metal of the kind used on animal drawn vehicles and hand trucks; lightning conductors. The control relating to certain specified parts (engine and chassis, &c.) of mechanically propelled road vehicles has been extended to cover all parts and accessories, wholly or mainly of metal, of such vehicles. Certain specified items (buffers, springs, wheels, &c.) of rolling stock, previously included as railway and tramway material, will now be covered by the comprehensive prohibition in respect of parts and accessories, wholly or mainly of metal, of rail locomotives and rail vehicles.

The Pig Iron Market

The volume of business in pig iron has been well maintained for some time, and recently licences have been issued covering purchases for January, 1942. Production has been on a high scale and the makers have been able to give fairly early delivery. There is a brisk demand for foundry pig iron, but the situation is comfortable and the demand is such that most furnaces are able to make slight additions to their stocks to meet any emergency which may arise during the winter months. The heavy foundries and those associated with the electrical and machine tool trades are well supplied with work and are making steady deliveries. Light castings makers, however, are not well employed and their requirements of high-phosphoric iron are easily met by the Midland producers. Jobbing foundries also are not so busy as they were, and although in some cases firms have a fair amount of work in hand, in the majority of cases they could do with more. The demand for low-phosphoric iron is heavy and the production passes almost at once into consumption. The demand has also grown very considerably of late for refined irons, but there are good tonnages available and consumers have little difficulty in covering their requirements. The Iron and Steel Control continues to exercise rigid supervision of hematite distribution and only in cases where the use of this iron is essential are applications for licences granted. It is suggested that the position is easier than a short time ago, but the majority of consumers do not find that this is the case. The firms engaged upon war work, however, have their needs well looked after and there has been no interruption in supplies to firms engaged upon essential work. In Scotland there is a strong demand for all grades of pig iron, but production is well maintained and consumers' requirements are being covered.

The Midlands and South Wales

Industrial activity in the Midlands is fully maintained at the rate that has been ruling the whole of this year. The demand for some descriptions of steel has decreased and this is particularly noticeable in the case of heavy joists and sections. This is principally because the constructional engineers are less busy than they were in the earlier part of the year and in many cases are finishing important jobs without seeing fresh work coming forward to replace completed contracts. On the other hand, the demand for plates appears to be growing, if anything, and the position remains stringent. Large quantities of plates of all thicknesses are passing into consumption. The shipyards in particular are providing an outlet for big tonnages, whilst tank and wagon builders are also actively employed and are requiring large supplies. The position of the sheet trade has improved. A few weeks ago new business was slow and many of the new works would have been glad to receive fresh orders, but recently large Government requirements have made their appearance in the market and the sheet mills are now busy and will remain so for a long period. The armaments and munition makers are important consumers of alloy steels and their requirements appear to be expanding. Production of these steels has increased and although the demand is taxing the resources of the manufacturers, on the whole it is being well met by the industry. An active business is passing in cold-rolled strip and bright-drawn steel bars. The re-rolling industry has experienced a few weeks of comparatively quiet business, but the situation has again changed and there is an increasing request for small bars and light sections. The iron and steel works in South Wales are fully employed and the works are engaged almost entirely upon Government work. Business in tinplates is moderate and almost entirely on home account.

Scotland and the North

The Scottish steel works are fully occupied on Government orders and little steel for non-essential work is being produced. The elimination of supplies for unessential work has enabled the steel makers to shorten their delivery dates and firms engaged on war work are getting deliveries much more promptly than they were earlier in the year. There is a particularly heavy demand for shipbuilding steel and plates and sections are passing to the yards in large tonnages. Supplies of plates are somewhat tight as a result of the heavy requirements of the shipyards and also of the tank makers, who are absorbing large quantities. The raw material position is, fortunately, satisfactory and there is no hindrance to the steel works from any shortness in this department. Scrap is required in large quantities and there is some preoccupation with the future position, but steps are being taken to press forward the collection from home sources which have not yet been tapped. The sheet makers are well employed and have recently received some important Government orders, which will keep them busy for a long time. In one or two cases, however, the sheet mills are not fully occupied and would be glad to receive more orders. The demand for alloy steels is growing and works are under considerable pressure to meet the demand, whilst there is a steadily increasing call for shell steel. The Scottish tube makers are comfortably placed and are working practically at capacity. The marine and heavy engineering works in Scotland are fully employed on Government work and their requirements of various descriptions of steel are heavy. Forgings and castings also are meeting with an insistent demand which is taxing the resources of the producers. In the Lancashire market one of the principal features is the activity in the alloy steel section. Engineering establishments employed on Government work are taking important deliveries and inquiry has considerably broadened during the past week or two. There is also an active demand for steel bars.

North-East Coast and Yorkshire

Although the demand for some classes of finished steel does not appear so insistent as was the case in the spring of this year, the works are kept fully occupied. Consumers, however, are obtaining delivery in reasonable time and the delays noticeable earlier in the year seem to be a thing of the past. This is largely due to the effectiveness of the Iron and Steel Control and its distribution scheme. One of the most satisfactory features of the situation is the maintenance of supplies of raw material. Larger supplies of certain classes of scrap would be welcome, but steps are being taken to increase the quantities available by drawing upon hitherto untapped home sources. The situation, so far as billets is concerned, is sound, and although American supplies have been drastically curtailed, no ill effects have been noticeable owing to the speed up of the home output. Most of the re-rollers are starting the winter with fair stocks of semis. The demand for small bars and light sections has shown a tendency to decline and some of the mills could do with more work. This, however, is regarded as only a temporary feature of the market, and it is expected that the demand will expand in the near future. The pressure to obtain plates is keeping the mills fully occupied. Shipyards and tank and boilermakers are large consumers and big tonnages are passing to these trades. Nevertheless, the supply position appears to be less stringent than it was only a short time ago, and although the producing works have a good tonnage of orders on their books they appear to have the situation well in hand. More active conditions have developed in the sheet market after a period of quietness, and the works which a few weeks ago were somewhat anxiously seeking business have now as much as they are likely to be able to deal with before the spring. The Yorkshire steel industry is actively engaged in all departments. There is a heavy demand for all classes of special steel, particularly alloy steels, which are being taken up in large quantities by the armaments and munition makers. The basic steel plants at Sheffield are increasing their output, whilst the crucible steel makers are fully employed. An active business is passing in rolled strip and bright-drawn steel.

Non-ferrous Metals

The copper position in Great Britain has not changed over the past few weeks, but, generally speaking, it remains satisfactory. Supplies continue to reach this country in adequate quantities and the war industries are receiving all the metal they need. Copper for ordinary commercial purposes is not easily obtained. The outlook seems satisfactory, but the Control is, nevertheless, carefully supervising all applications for licences. In the United States the position does not seem quite so tight as a few weeks ago, although concern is still expressed as to the future. It seems doubtful, however, if any real shortage of the metal will develop in America, considering the supplies which it is possible to draw from South America. In fact the Allies have so large a proportion of the copper supplies of the world under their hand that anything more than a temporary stringency seems unlikely. It has been announced in the United States that the administration has decided to take over the production of three Michigan mines on a cost plus basis, the price mentioned being 15c. The official domestic quotation remains at 12c. But presumably the mines referred to are high-cost producers and the policy of the administration is to enable mines which are unable to produce cheaply to make a reasonable profit. . . . The tin market has remained in a lethargic condition. Representations have been made to the authorities to resume the issue of export licences. It is not thought likely, however, that the authorities will take this course until the end of the year. Considerable tonnages of tin are understood to have been purchased by Russia and it is thought that these are likely to be maintained at the rate of 1000 to 1500 tons per month. The question has been discussed as to whether these Russian purchases will affect supplies of tin to the United States, but America is believed to hold good stocks. It is suggested that the London market may become somewhat brighter if export licences for tin are issued, and it is probable that the cash price would harden and that the contango would contract. . . . The consumption of lead by the war industries continues upon a heavy scale. The cable and battery makers are fully employed and are taking up large quantities. Russia is also said to be receiving supplies of Empire lead, and in view of these factors in the position it is probable that less lead will be allowed in the future to go into unessential work. . . . Rather tight conditions continue to rule in the spelter department. Extremely active conditions prevail in the brass industry and large tonnages of spelter are being absorbed. The galvanising industry also has been taking larger quantities than of late.

Notes and Memoranda

Rail and Road

TRANSPORT IN JAPAN.—The Japanese Government has appointed a permanent committee to represent railways, air transport, ports, along with materials and equipment, and to deal with matters of common interest to transport in Japan, her colonies, and occupied territories.

TRAINS FOR FACTORY WORKERS.—Extra trains run by the L.M.S. Railway for workers at Government factories now total 267 a day. On Sundays no fewer than 209 special "Workers Only" trains are operated. These are additional to the large number of services used by workers at factories not directly under Government control.

JUBILEE OF A TUNNEL.—The St. Clair River railway tunnel at Sarnia, Ont., which connects Sarnia with Port Huron, Mich., is still in use after fifty years of service. Believed to be the first international submarine tunnel, during the past forty-one years the tube has been in continuous daily service for Canadian National trains travelling between Chicago and Montreal, *viâ* Toronto. The tunnel proper is 6000ft. in length.

ACETYLENE GAS FOR TRANSPORT.—The possibility of using acetylene gas as a means of transport is being discussed again. In 1940 it was reported that the driving of motor vehicles by calcium carbide was being carried out upon an experimental scale in Sweden, and to a lesser extent also in Denmark and Norway. Known as the "Karbil" system, the inventor is Mr. Sture Hjelm, a civil engineer in the service of the Swedish Ericsson Company. One of the chief features appears to be a special form of air and gas mixer device which is claimed to produce a constant gas mixture at all speeds and loads. It is stated that with a large car a charge of 66 lb. of carbide is sufficient for 120 miles run.

Air and Water

OXYGEN CUT MANHOLE COVERS.—The Montreal Municipality has installed a welding and cutting plant for making manhole covers. It is designed to cut cover and frame from ⅜in. chequered steel plate, which is first cut into rectangles 30in. by 24in., and from this the round cover is cut, leaving the frame ready for further work. When it was first decided to produce these covers by oxygen cutting a hand cutting torch was used for the work, but was necessarily slow, fifty-three hours being required to produce 100 covers and frames. By using the new machine the time per 100 was reduced to twenty-eight hours, with a cleaner job.

THE TACOMA BRIDGE.—The Tacoma Narrows bridge insurance suit has been settled, and the Washington State Toll Bridge Authority has been awarded 4,000,000 dollars in cash and all that can be salvaged from the old bridge. The engineers for the Authority, under Mr. C. E. Andrew, State Bridge Engineer, are working on plans for a new structure to utilise the existing piers. Eight designs are reported to be under consideration. A four-lane roadway, as compared to the former two-lane structure, is believed to be assured. The deck would be carried on an open truss, offering less resistance to the wind than the original bridge deck, which was supported between girders. No attempt will be made to use the towers or cables of the collapsed bridge.

A MEDITERRANEAN NAVAL SUCCESS.—An Admiralty message on Sunday evening last announced that two convoys of enemy supply ships were annihilated in the Central Mediterranean and severe losses were inflicted on their escorts in a brilliant and determined action by his Majesty's ships. A patrolling force consisting of the cruisers H.M.S. "Aurora" and "Penelope," with the destroyers H.M.S. "Lance" and H.M.S. "Lively," made contact on Sunday morning, about 1 a.m., with a large convoy of eight supply ships escorted by two destroyers, which had been recently joined by two other supply ships escorted by two destroyers. The operation was being covered by two Italian cruisers of the "Trento" 10,000-ton class, mounted with 8in. guns. Nine of the ten enemy supply ships were set on fire and sunk. One of them was an ammunition ship, which blew up. The tenth enemy supply ship, a laden tanker of about 10,000 tons, was left blazing furiously. This ship was seen to be still burning ten hours later, and it is considered that she is a total loss. Of the Italian warships, one destroyer was sunk and at least one other seriously damaged. One destroyer was seen to be in tow afterwards. No casualties or damage was suffered by his Majesty's ships in this engagement. On Tuesday evening a further Admiralty communication stated that it was now known that in Sunday's action three Italian destroyers were sunk and two seriously damaged. Recent submarine action has sunk four enemy troopships or supply ships in the Mediterranean, while two armed merchant cruisers and two supply ships were seriously damaged.

Miscellanea

ORDNANCE WORKERS IN INDIA.—The scheme inaugurated early in the war for the training of thousands of technicians of various categories for ordnance factories in India has achieved remarkable results. The British Treasury has approved a revenue charge to cover the cost of the training.

WHAT ARE "MACHINE TOOLS"?—In one of the U.S.A. aircraft works trouble has arisen over the interpretation of the term "machine tool." The difficulty was overcome by an official ruling which defines the term "machine tool," when assigned a preference rating, as covering not only machine tools, but fixtures, attachments, machining jigs, measuring devices, punches, hydraulic presses, dies, forging hammers, furnaces and all instruments and attachments necessary for the operation of these machines.

THE LATE MR. W. N. WESTON.—We regret to have to announce the death, on November 1st, of Mr. W. N. Weston, M.I. Mech. E., at his home in Loughborough. He was closely associated with Herbert Morris, Ltd., Loughborough, for over thirty years, and for the last quarter of a century he had been an active director of the company. His principal preoccupation was with the development and application of electric overhead cranes and many other kinds of power-operated lifting and handling gear.

MACHINE TOOL CONTROL.—A meeting was recently held in London at which machine tool users were represented. Lord Beaverbrook asked for endorsement of his policy, which was unanimously given. The policy has now been put into effect. It consists of five points:—(1) That the Machine Tool Control should take decisions to remove machine tools from a factory without appeal; (2) in cases where tools are idle at night the available labour should be divided into two shifts, one by day and one by night; (3) machine tools shall be supplied only to firms with night shifts; (4) a return shall be required of machine tools not at present in use; (5) a return of all cutting tools shall be required from every firm.

ANTI-DERMATITIS PREPARATIONS.—The Board of Trade has issued a General Licence permitting the supply, outside quota, of anti-dermatitis preparations to firms engaged in a number of activities, including the supply of electricity or gas, the production of coal, the operation, construction, maintenance and repair of motor vehicles or trailers, engineering and metal plating. Firms wishing to obtain these supplies must send to their supplier a declaration stating the value of the goods required and the nature of the business which the firms carry on. They must also state that the goods will be used solely for the prevention of dermatitis among their employees, and will not be resold to the public. A wholesaler receiving a declaration in this form can pass it back to the manufacturer from whom he obtains his supplies and it will then serve as an authority for the latter to supply goods outside quota.

Personal and Business

MR. C. D. TAITE has been appointed managing director of the Lancashire Electric Power Company.

SIR PHILIP HALDIN has been elected Chairman of the Deep Sea Tramp Section of the Chamber of Shipping.

MR. R. A. S. THWAITES has been appointed Deputy Electrical Engineer to the Manchester Corporation.

MR. BERNARD THOMAS has been appointed managing director of Midland Heat Treatments, Ltd., Wolverhampton.

LIEUT.-COLONEL C. G. VICKERS, V.C., has been appointed a part-time member of the London Passenger Transport Board.

THE MINISTER OF SUPPLY has appointed Mr. C. J. Brockbank as Controller of Abrasives. The address of the Control is Palace Chambers, Bridge Street, Westminster, S.W.1.

ADMIRAL OF THE FLEET LORD CHATFIELD has accepted the invitation of the Council of the Institution of Naval Architects to succeed the late Viscount Stonehaven as President of the Institution.

THE TIMBER CONTROLLER has released Mr. Colin Darby to take up the post of Senior Deputy Director in the Home-grown Timber Department. Mr. Darby will be second in command in the Production Department under the Director, Mr. Gerard Lenanton.

THE MINISTER OF SUPPLY has appointed Mr. W. A. Robotham, head of the tank development department of Rolls-Royce, to be Chief Engineer on Tank Design under Mr. Oliver Lucas, the Controller-General of Research and Development, Ministry of Supply.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that in order to make sure of its insertion the necessary information should reach this office on or before the morning of the Monday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

Bradford Engineering Society

Monday, Nov. 24th.—Technical College, Bradford. "The Measurement of Surface Finish," C. Jolliffe. 7.15 p.m.

Institute of Fuel

Thursday, Nov. 20th.—Queen's Hotel, Leeds. "Liquid Pitch Fuel," E. Brett Davies. 2.30 p.m.

Institute of Transport

Tuesday, Nov. 25th.—Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. "Operating Problems After the War," C. F. Klapper. 1.15 p.m.

Institution of Automobile Engineers

Saturday, Nov. 22nd.—Engineers' Club, Albert Square, Manchester. "The Prevention of Accidents from the Technical Aspect," E. G. Beaumont. 3 p.m.

Institution of Electrical Engineers

Saturday, Nov. 15th.—N. MIDLAND CENTRE: Hotel Metropole, King Street, Leeds. "The Characteristics and Performance in Service of High-voltage Porcelain Insulators," J. S. Forrest. 2.30 p.m.

Thursday, Nov. 20th.—Savoy Place, Victoria Embankment, W.C.2. "The Characteristics and Performance in Service of High-voltage Porcelain Insulators," J. S. Forrest. 4 p.m.

Friday, Nov. 21st.—N. EASTERN STUDENTS: Neville Hall, Westgate Road, Newcastle-upon-Tyne. "Modern Electric Clocks," M. N. Karsaosman. 6.30 p.m.

Monday, Nov. 24th.—N.E. CENTRE: Neville Hall, Westgate Road, Newcastle-upon-Tyne. Informal discussion on Post-war Planning. 6.15 p.m.

Institution of Engineers and Shipbuilders in Scotland

Tuesday, Nov. 18th.—39, Elmbank Crescent, Glasgow. "Some Developments and Applications of Mechanical Refrigeration," P. B. H. Brown. 6.30 p.m.

Institution of Engineers-in-Charge

Saturday, Nov. 15th.—Magnet House, Kingsway, W.C.2. "Electric Furnaces," V. O. Cutts. 2 p.m.

Institution of Mechanical Engineers

Friday, Nov. 21st.—Storey's Gate, Westminster, S.W.1. Hawksley Lecture, "A Century of Tunnelling," W. T. Halcrow. 2.30 p.m.

Saturday, Nov. 22nd.—N.W. BRANCH: Engineers' Club, Albert Square, Manchester. "Munitions Labour Supply Organisation," W. H. Denholm. 2.30 p.m.

Institution of Production Engineers

To-day, Nov. 14th.—N.E. SECTION: County Hotel, Newcastle-upon-Tyne. "How to Get the Best Out of Your Broaches," V. A. A. Holmes, and "The Grinding Wheel and Production," F. W. Vickery. 6.15 p.m.

Saturday, Nov. 22nd.—EDINBURGH SECTION: North British Station Hotel, Edinburgh. "Electrical Deposition of Metals and the Anodic Treatment of Aluminium," S. Murray. 3 p.m.

Wednesday, Nov. 26th.—SHEFFIELD SECTION: Grand Hotel, Sheffield. "The Manufacture of Precision Measuring Tools," A. E. Morrison. 6.30 p.m.

Saturday, Nov. 29th.—MANCHESTER SECTION: College of Technology, Manchester. "Surface Finish," G. Schlesinger. 2.15 p.m.

Junior Institution of Engineers

Saturday, Nov. 15th.—39, Victoria Street, S.W.1. Annual general meeting. 2.30 p.m.

Saturday, Nov. 29th.—39, Victoria Street, S.W.1. "The Engineer and the Rest of the World: A Study in Relationships," K. S. Jewson. 2.30 p.m.

Keighley Association of Engineers

Friday, Nov. 28th.—Victoria Hotel, Keighley. "Impact and Notched Bar Testing," C. N. Waterhouse. 7 p.m.

Manchester Association of Engineers

Saturday, Nov. 15th.—Engineers' Club, Albert Square, Manchester. "Applications of Photography in Engineering," D. A. Spencer. 2.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders

To-day, Nov. 14th.—Mining Institute, Newcastle-upon-Tyne. "Wind Tunnel Experiments on Model Reaction Turbine Blades," M. R. Youssef. 6 p.m.

Society of Glass Technology

Wednesday, Nov. 19th.—"Elmfield," Northumberland Road, Sheffield. Symposium on Glass Furnace Problems. 10 a.m.